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ANNALS
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NEW OLIGOCENE BRACONIDAE AND BETHYLIDAE FROM BALTIC AMBER

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The present paper is based on material contained in the large Haren Collection of Baltic amber insects recently acquired by the Musuem of Comparative Zoology. It supplements the much more lengthy account dealing with these two families which was prepared some years ago by the writer, from a study of specimens belonging to these families in the collections of the Amber Museum of the University of Konigsberg, and published in 1933.[1]

In the present series a number of the previously described species are represented but it contains also some interesting ones not previously known. Several of these are so unusual that they have been made the types of new genera. The discovery of such a surprisingly large number of peculiar forms only serves to emphasize again the fact that these families were already very highly diversified in Lower Oligocene times.

I am deeply indebted to Mrs. A. S. O'Connor who has drawn the figures that accompany the descriptive matter.

Family **Braconidae**

Subfamily **Doryctinae**

Anacanthobracon Gen. nov.

♂. Head more or less cubical, about as long as wide in dorsal view. Eyes round, slightly protuberant. Head devoid of any spines or projections, except for the rather prominent upper margin of the

[1]The Parasitic Hymenoptera of the Baltic Amber. Bernstein-Forschungen, Heft 3, pp. 4–178, 13 pls., 87 figs.

mouth opening. Antennae thin, long and tapering, exceeding the body in length. Maxillary palpi long, 4-jointed; labials 3-jointed. Thorax short, nearly cylindrical; mesonotum elevated medially in front, the notauli present; mesopleura long, the front and middle coxae very

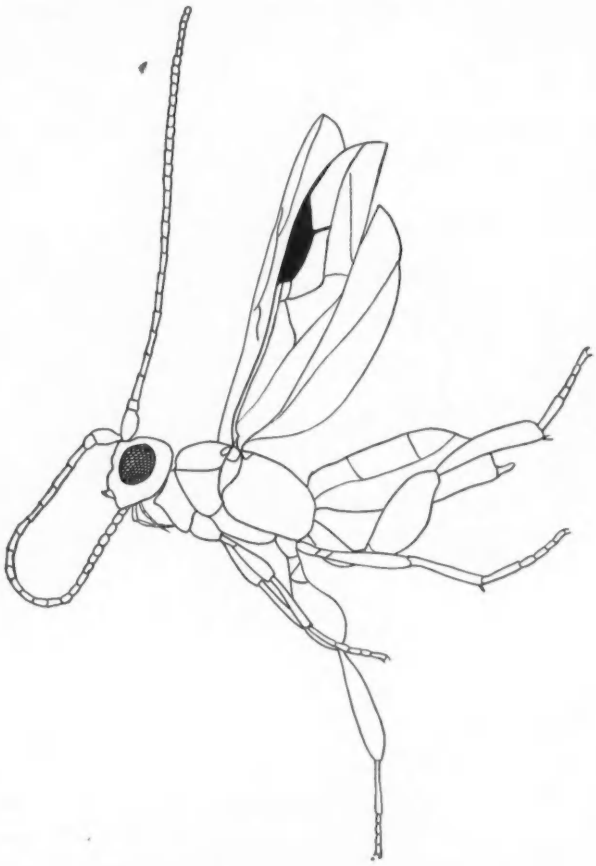

FIG. 1. *Anacanthobracon femorator* sp. nov.

widely separated from one another; propodeum short, rounded behind, not areolated. Abdomen short, consisting of only three tergites, the apical part and venter membranous; the three tergites are subequal and together shorter than the thorax and the membranous extruded apical portion, bearing the claspers at apex is half as long as the sclero-

tized tergites. Four anterior legs slender, their femora feebly clavate; hind legs greatly thickened; their coxae large, elongate, simple; femora less than three times as long as thick, more sharply narrowed at base than at apex; tibiae stout, strongly thickened apically and noticeably curved, their apical spurs short. Nervulus postfurcal; radial cell moderately long, the third section of the radius almost parallel to the first intercubitus which is fully twice as long as the second intercubitus; second cubital cell nearly four times as long below as above; recurrent nervure entering the base of the second cubital cell.

Type. *A. femorator* sp. nov.

This is undoubtedly referable to the Doryctinae, but is widely different from any described living genus. The peculiar shape of the second cubital cell is a gross exaggeration of the tendency seen in several genera for the second section of the radius to be much shortened and the thickening of the hind legs is likewise surprisingly pronounced, particularly on account of the strongly arcuate tibiae. The reduction of the abdominal tergites to form a three parted dorsal shield renders it quite unique in this subfamily. Although it shows some similarity to Digastrotheca Brues from the Baltic Amber in the form of the abdomen, I believe the resemblance does not indicate any relationship, as Digastrotheca, known only in the female sex, seems unquestionably to belong to the Rhogadinae.

Anacanthobracon femorator sp. nov.

(Fig. 1)

♂. Length 3 mm.; to tip of last abdominal plate, 2.7 mm. Apparently black, with the legs lighter beyond the femora; wings quite distinctly infuscated. Antennae 31-jointed; scape oval, twice as long as the quadrate pedicel; flagellum very thin, the basal joints about three times as long as thick, thence shorter until those near apex are minute, but still cylindrical and clearly longer than wide.

Type, M. C. Z., No. 6710.

Subfamily **Triaspidinae**

Heretofore no member of this group has been found in the Baltic, although it has been recognized in other Tertiary deposits. From the Miocene Shales of Florissant[2] the present writer described as *Urosigalphus aeternus* an undoubted triaspidine, although the generic reference is somewhat doubtful. From the Oligocene of the Isle of Wight Cockerell described

[2]Bull. Mus. Comp. Zool., vol. 54, p. 96, 1910.

Sigalphus (?) *cervicalis*,[3] but his figure represents a braconid that is certainly not a member of this subfamily.

In the present collection there is a single female which is very clearly a member of the Triaspidinae, but does not seem to be referable to any described genus. In habitus it agrees with Triaspis and others, but the neuration is distinctive in that the recurrent nervure is practically interstitial with the first transverse cubitus and the discoidal cell is petiolate above. However, the thoracic and abdominal details are not visible with sufficient clarity to permit of a complete diagnosis. It is therefore referred to for the present as a Triaspis *s. lat.*

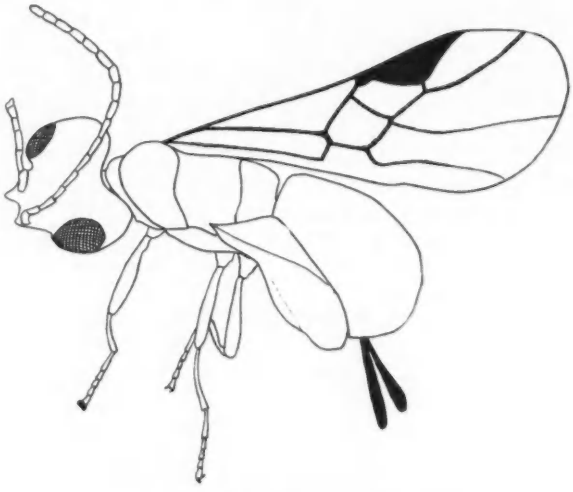

FIG. 2. *Triaspis anomala* sp. nov.

Triaspis anomala sp. nov.

(Fig. 2)

♀. Length 1.8 mm. Entirely black, but this may not be the original color; wings hyaline, stigma dark brown, venation pale brown. Head large, more or less cubical with the temples swollen behind and the occiput deeply, roundly emarginate when seen from above. Face produced just below the insertion of the antennae as two conical projections on the upper side of which the antennae are inserted; seen from above the projections are triangular, slightly rounded at tip,

[3]Ann. Mag. Nat. Hist. (9), vol. 7, p. 14 (1921).

closely approximate and rise above the surface to about half the thickness of the head. Eyes bulging, about as long as the width of the temples. Antennae with more than 14 joints (tips not preserved); scape short, stout; inserted in the concave upper surface of the facial tooth on each side; pedicel oval, much thicker than the long, slender first flagellar joint; second flagellar joint shorter and thicker, following ones growing shorter, of the same thickness. Surface of head and of thorax above smooth; propodeum finely and shallowly reticulate. Parapsidal furrows present; propodeum short, slightly concave on its posterior face. Abdomen only slightly longer than the thorax, oval and larger behind, its surface shining at the base, but the apical part is obscured by an opaque whitish coating; suture between the first and second tergites distinct, but not deep; first segment medially with a pair of carinae that converge behind. Posterior margin of carapace smooth with a finely raised margin. Ovipositor projecting, fully two-thirds as long as the abdomen. Stigma broad, triangular, the radius arising at the middle; anal cell without any trace of a cross-vein; nervulus postfurcal by three-fourths its length; first discoidal cell petiolate, the cubitus arising at the upper fourth of the basal vein; first section of radius very short, second section curved, ending halfway between the stigma and wing tip; first section of cubitus weaker than the other veins, but complete; second section obsolete, except at the extreme base; recurrent nervure interstitial with the transverse cubitus.

Type, No. 9292, M. C. Z.

This is a peculiar species, particularly in the presence of the horns below the insertion of the antennae. It may possibly represent a new genus.

Subfamily **Diospilinae**

Microtypus grandis sp. nov.

(Fig. 3)

♀. Length 5 mm.; ovipositor 3.3 mm., its sheaths 3 mm. Black; the wings presumably hyaline with brown venation although much stained in the type specimen. Eyes approaching close to the base of the mandibles, one-half wider than the temples; surface of head behind the eyes sparsely and finely punctate. Antennae long and slender, with 29 joints, tapering on the apical portion; scape large, half as long as the eye; pedicel, small, oval; first, second and third joints of flagellum subequal, each about three times as long as thick; following rapidly, then slowly growing shorter, all of them at least slightly longer than wide. Maxillary palpi with the second joint greatly swollen below. Mesonotum with the median lobe raised; the notauli deep, but apparently not crenulate, convergent behind. Propodeum deeply reticulate over its upper surface and on the sides at base and apex. First tergite more or less longitudinally roughened above, as long as the second and third tergites together; remainder of abdomen smooth, the second

tergite slightly longer than the third, separated from it by a fine suture; following tergites very much shorter. Stigma not very wide, the radius arising just beyond the middle. First section of radius barely longer than the second, third section faintly recurved apically and extending nearly to the tip of the wing; basal vein curved, the cubitus arising from its upper end; first intercubitus about as long as the first section of the cubitus; second section of radius about half as long as the second section of the cubitus; nervulus slightly postfurcal; recurrent nervure entering the first cubital cell about one-fourth its own length before the intercubitus. Legs slender, the hind coxae very large. Sheaths of ovipositor very minutely hairy.

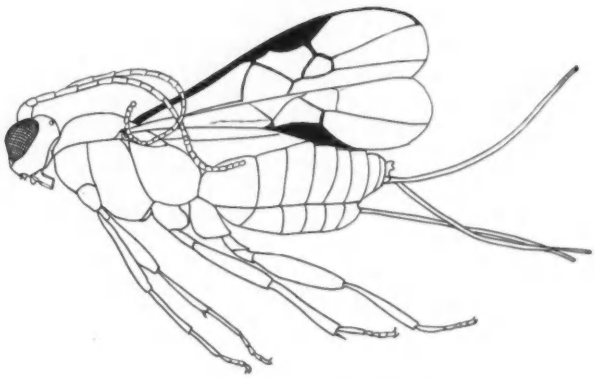

FIG. 3. *Microtypus grandis* sp. nov.

Type, No. 7842, M. C. Z.

This species is similar to *M. latipennis* Brues to which it will run in the key to Baltic amber species (Bernstein-Forschungen, p. 80). It differs by its much larger size, 5 mm. instead of 2.75 mm. and in having the recurrent nervure much nearer to the intercubitus.

Subfamily **Blacinae**

Blacus Nees

There are a number of specimens of this genus in the collection, including one species that appears to be undescribed. This increases the known number of Baltic amber species of Blacus to six.

Blacus gracilicornis sp. nov.

(Fig. 4)

♀. Length 2.3 mm.; ovipositor 1.7 mm., or about as long as the head and thorax together. Similar to *B. crassicornis* Brues, but differing by the much longer basal flageller joints. Black, the abdomen and legs appearing brownish. Head smooth and shining. Eyes large, the malar space hardly as wide as the base of the mandible. Ocelli large, separated by about their own diameter. Antennae 17-jointed; scape short, one-half longer than wide; pedicel narrower, nearly quadrate; first and second flagellar joints each fully four times as long as

FIG. 4. *Blacus gracilicornis* sp. nov.

thick, of about equal length; next two joints three times as long as thick; succeeding ones gradually shorter, but elongate, the penultimate one one-third longer than wide. Notauli meeting before the base of the scutellum, deep and coarsely crenulate. Propodeum areolated, the carinae not very high although very clearly marked. First three abdominal tergites of about equal length, the basal one slightly longer; second suture fine, linear. Ovipositor and sheaths slender. Legs moderately slender. Stigma elongate triangular, the radius arising beyond the middle; first section of radius slightly oblique; two-thirds as long as the width of the stigma; second section noticeably curved near its basal third, ending slightly before the wing-tip. First discoidal cell not petiolate, the cubitus arising at the upper end of the basal vein; nervulus postfurcal by half its length, vertical; recurrent nervure entering the cubital cell just before its tip, parallel with the transverse cubitus and very nearly in line with it, first section of cubitus and transverse cubitus

of equal length, each about three times as long as the first section of the radius.

Type, No. 9400, M. C. Z.

This species will run to *B. crassicornis* Brues in my key to species (Bernstein-Forschungen, p. 82) on account of the small number of antennal joints and aside from the more slender antennae it is very similar.

Subfamily **Meteorinae**

There is a peculiar species in the present collection which is very similar to the large, more or less polymorphic genus Meteorus, but it lacks entirely the second transverse cubitus as in the subfamily Euphorinae. It does not have the habitus of the latter group however and in spite of the lack of this vein is undoubtedly more closely allied to living Meteorinae although it will not run there in current keys. Whether it represents a transition between the two groups seems doubtful as it shows little resemblance to any genus of Euphorinae known to me.

Meteorites Gen. nov.

♀. Body slender, the abdomen with a long, narrow, evenly curved petiole. Head wide, with large eyes; antennae 13 or 14-jointed, with elongate cylindrical joints. Thorax about as long as high, the propodeum gradually rounded off behind, with a lateral carina; notauli complete; mesopleura large. Abdomen elongate, more or less compressed apically, longer than the head and thorax together; seen from the side it is nearly truncate at tip with a short ovipositor which is thick at the base, tapering and strongly arcuate. Legs slender. Wings with a broad triangular stigma and long, narrow marginal cell; first discoidal cell petiolate above; first cubital cell complete, but the cubitus obsolete beyond it; nervulus nearly interstitial as is also the recurrent nervure.

Type, *M. inopinata* sp. nov.

Meteorites inopinata sp. nov.

(Fig. 5)

♀. Length 2.6 mm.; ovipositor 0.28 mm. Color probably black, with the abdomen and legs brown and the wings slightly infuscated with dark brown venation. Head shining, the surface shagreened quite uniformly throughout; eyes large, bulging, extending nearly to the base of the mandibles; ocelli in a small triangle, of good size, but much smaller than in Meteorus; posterior marginal line of head delicate, but complete; neither face nor clypeus noticeably protuberant. Scape and pedicel of antennae of about equal length; first five joints of flagellum subequal, the first narrow, nearly cylindrical, the second

widened apically; third of even width, about twice as long as thick; following joints imperceptibly smaller. Mesonotum weakly trilobed anteriorly, the notauli very shallow; behind with a depression before the scutellum. Mesonotum smooth and polished, with a punctate area above; propodeum punctate-reticulate, impressed medially behind

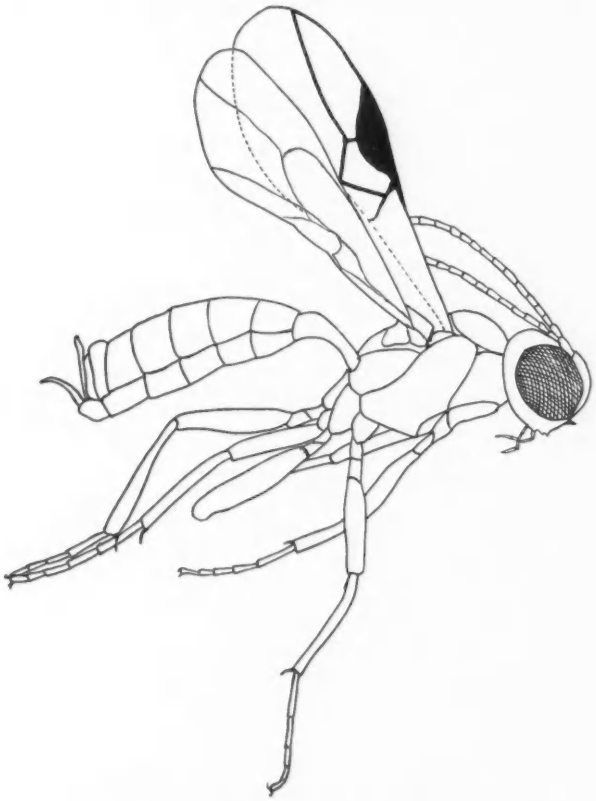

FIG. 5. *Meteorites inopinata* sp. nov.

above the insertion of the abdominal petiole. First abdominal tergite evenly curved, the spiracles apparently beyond the middle; surface punctulate, but no striae are visible in the type; second and third tergites about equal in length, together a little longer than the first, separated by a fine, weakly impressed suture; fourth, fifth and sixth tergites gradually shorter; seventh much shorter, its ventral surface vertical so that in side view the short sheaths and ovipositor arise at the lower corner and project upwards. Stigma oval at base, triangular apically, nearly

half as wide as long, the radius arising at the middle. First section of radius nearly vertical, extremely short, less than one-fourth the width of the stigma; second section a little less than twice the length of the stigma, reaching nearly to the tip of the wing; nervulus very slightly postfurcal; first discoidal cell petiolate above, the cubitus arising near the upper third of the basal vein; recurrent nervure almost exactly interstitial; second transverse cubitus entirely absent.

Type, No. 9395 M. C. Z.

Family **Bethylidae**

Misepyris Kieffer

Two species of this genus have already been described from the Baltic Amber and the present collection contains another.

FIG. 6. *Misepyris minor* sp. nov.

Misepyris minor sp. nov.

(Fig. 6)

♀. Length 1.8 mm. Black, or very dark colored, the thorax with a strong aëneous reflection; antennae and legs brown; wings hyaline, the stigma black and the veins rather pale brown. Head about as wide as long; shining above with the surface confluently punctulate or rugulose. Ocelli in an equilateral triangle, closer to one another than to the eye-margin. Antennae 13-jointed, their tips reaching nearly to the tegula; scape stout, but little more than twice as long as

thick; pedicel more than half as long as the scape and two-thirds as thick as the scape; flagellar joints about quadrate, flagellum much narrower than the pedicel basally, but strongly thickened apically; last joint fully twice as long as the penultimate one. Prothorax long; exclusive of the neck, fully twice the length of the short, transverse mesonotum. Parapsidal furrows strongly convergent behind. Scutellum with a deeply curved groove at the base, but without foveae. Propodeum almost as long as the mesonotum and scutellum together, finely reticulately rugose; its dorsal surface with lateral carinae as well as a basal, apical and median longitudinal one. Abdomen smooth, polished, about as long as the head and thorax together. Legs rather short, the femora stout, especially the front pair. Wings typical for the genus, with two fully enclosed basal cells, the second discoidal cell practically obsolete, the radius arising near the tip of the stigma, gently curved and complete for three-fourths of its length; costa with extremely minute bristles.

Type, No. 6634, M. C. Z.

The present species differs from the Oligocene *M. robustus* Brues by its smaller size, longer antennae, longer pronotum and less widely separated ocelli. Like the latter it resembles *M. longiceps* Kieffer more closely than any other described living species.

Ctenobethylus Gen. nov.

♀. Wingless, but with the thorax not very greatly modified. Head considerably longer than wide, the occipital margin strongly emarginate; eyes small, placed well up on the sides of the head, not very far from the clypeus. Mandibles expanded apically, with broad tips, with two well developed apical teeth and a series of at least seven denticles of decreasing size forming an inner blade. Antennae 13-jointed, the flagellum distinctly thickened at apex. Ocelli absent. Thorax elongate, widest at the middle of the pronotum and much narrowed posteriorly, the pronotum fully one half wider than long, its posterior margin arcuately emarginate for its entire length; mesonotum about as wide as long, but only about half the width of the pronotum, without parapsidal furrows, its sides nearly straight, but converging apically with the apex truncate or slightly concave. Scutellum apparently not developed. Propodeum sloping gradually, without any distinct carinae so far as can be seen. Abdomen as long as the head and thorax together; second, third and fourth segments occupying most of its upper surface. Legs unusually slender, except the front pair; none of the tibiae spinose.

Type, Ctenobethylus succinalis sp. nov.

This is the second species of Bethylidae with an apterous female to be discovered in the amber. Structurally it is similar to Apenesia, but the dentition of the mandibles is very unusual as there are rarely more than four teeth present. Glenosema Kieffer has the mandible armed with six or seven large teeth and

is similar in many respects, but the propodeum is margined and the ocelli are present. Cephalonomia Westwood is likewise quite similar, but the antennae are 12-jointed. The tibiae are simple, not bristly as in Apenesia. In mandibular structure the present genus resembles the South African Paralaelius Cameron which has one long apical tooth and numerous smaller denticles. The propodeum of the latter is however of the Epyris type, with several longitudinal keels. From Neoscleroderma Kieffer the new genus differs by the long antennal scape, slender legs and peculiar dentition of the mandibles.

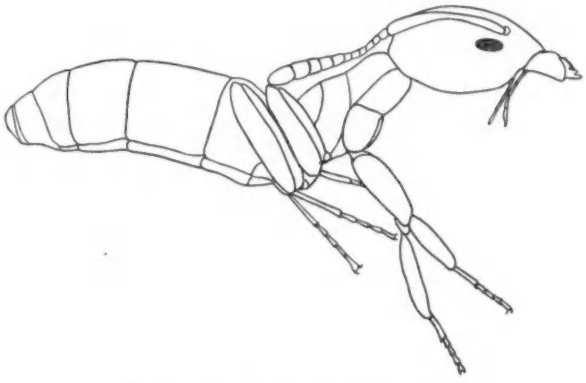

FIG. 7. *Ctenobethylus succinalis* sp. nov.

Ctenobethylus succinalis sp. nov.

(Fig. 7)

♀. Length 2.8 mm. Color as preserved, dull ferruginous, the head darker brown and also to some extent the upper surface of the thorax and abdomen; flagellum of antennae very light brown. Head very minutely punctulate, almost smooth at the sides and apparently above also. Eyes small oval, one-third longer than wide, removed from the base of the mandibles by slightly more than their own length. Mandibles large, at least twice as broad at tip as at the base, the apical tooth long, triangular, acute; second tooth much shorter and narrower; the minute denticles that follow gradually decreasing in size, forming a serrate edge. Antennae long, the scape slender, extending to the vertex; pedicel larger than the basal flagellar joints, decidedly longer than wide; joints of flagellum gradually increasing in length, the first wider than long; following more or less quadrate, the antepenultimate decidedly longer than wide and fully one-half thicker than the first, the last two joints subequal and together as long as the antepenultimate although the suture between them is not very clearly visible; tip of

antenna reaching to the tip of the propodeum. Thorax, as nearly as can be discerned, smooth, impunctate and shining, although it is slightly obscured by imperfections in the amber. Abdomen smooth, about as wide as the head.

Type, No. 7666, M. C. Z.

Homoglenus Kieffer

There is a single species which runs directly to this genus in Kieffer's key to the Bethylidae in Das Tierreich. It differs from the described living species in having the parapsidal furrows lacking, although the lateral furrows are well developed. Such discrepancies are admitted in certain other genera, *e. g.*, Pristocera and it seems unwise to propose another generic name for the fossil species.

Homoglenus bifossatus sp. nov.

♂. Length 2.75 mm. Apparently black or very dark, the legs and antennae more brownish and the wings slightly infuscated. Head short oval, the eyes large, nearly round, bare, extending from close to the mandibles more than halfway to the vertex; sides of head behind the eyes not as wide as the eye. Antennae 13-jointed; scape very short, curved, not much thicker than the flagellum; pedicel very short, transverse, narrower than and only one-third the length of the first flagellar joint; all joints of flagellum of subequal length, but growing more slender apically, the basal ones about three times as long as thick. Mandible with five apical teeth, the lowest one longer than the others. Ocelli large, in a small triangle, separated by about their own diameter. Surface of head shining, minutely punctulate. Pronotum more or less evenly narrowed anteriorly, its posterior margin simple, strongly concave. Mesonotum as long as the pronotum, without parapsidal furrows, but with the lateral furrows deeply impressed on their posterior two-thirds and absent in front. Scutellum large, triangular, as long as wide and nearly as long as the mesonotum; basal groove of scutellum narrow, deep, coalescing with a small fovea at each side. Surface of pronotum, mesonotum and scutellum shining, sparsely punctulate. Propodeum coarsely irregularly reticulate above and behind, smooth or minutely reticulate on the pleurae, margined at base and apex and with three longitudinal carinae above which are more highly elevated than the reticulations. Abdomen short, convex, the second tergite longest. Legs stout; all the femora thickened. Wings with the radial vein long, very nearly closing the cell, arising from near the apex of the rather small stigma; basal vein short, straight, entering the costal vein about half its own length before the stigma; both basal cells enclosed by heavy veins, the median vein continuing beyond the cell for a considerable distance.

Type, No. 7679, M. C. Z.

DIPLOPTERA DYTISCOIDES, A VIVIPAROUS ROACH WITH ELONGATE PLEUROPODIA

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Of the sixteen species of cockroach in the Hawaiian Islands that are listed by Williams (1931) a few, perhaps three or four, are thought to be viviparous. Specimens of the readily available forms were collected and dissected but only one, *Diploptera dytiscoides* (Serville), upon examination seemed indubitably to possess the characteristics of a viviparous insect. This roach, the most abundant in the Islands, is known locally as the "beetle roach" or "cypress girdler." It is not addicted to dwellings but abounds in the decaying leaves covering the soil.

The embryo and the mother present a whole series of remarkable adjustments to the viviparous condition though only a few of immediate concern need be mentioned. The eggs, twelve in number, pass from the six ovarioles of each ovary into an enlarged sac-like uterus which they occupy till emergence. All hatch simultaneously and the offspring are born in rapid succession. Usually cockroaches have many more ovarioles and the eggs, consequently, are numerous. Presumably the females of this species may produce subsequent clutches for several additional oocytes, in various degrees of maturity, lie in each ovariole.

It will be recalled that in all previous records any viviparously produced insect arising from an ovum covered by a chorion, or shell, invariably is accompanied by sufficient yolk within the egg to bring it to the hatching period. This species does not conform to the general rule for the egg is very small and the supply of yolk is limited. The embryo, however, has nutrient organs which surmount quite effectively the barrier of an impervious chorion and with their aid obtains surplus nourishment through the micropyle. The nutrient organs, like those of the Polyctenidae (Hagan, 1931), consist of persistent pleuropodia, or embryonic appendages on the first abdominal segment, of very remarkable length.

Referring to the accompanying figure one can see that the pleuropodia are enlarged (c) and bulbous basally where they

project (a) from the body wall (w). They continue distally as slender, hollow tubes (e) to the tip of the abdomen, turn dorsally (m), and grow anteriorly (n) to the micropylar area.

Shortly after narrowing to a delicate tube, beyond the proximal enlarged portion, the pleuropodium penetrates the amnion, serosa, and the vitelline membrane to emerge immediately beneath the chorion, against which it is firmly pressed. The illustration shows both pleuropodia, dissected from the embryo, still held close to the internal surface of the chorion by the

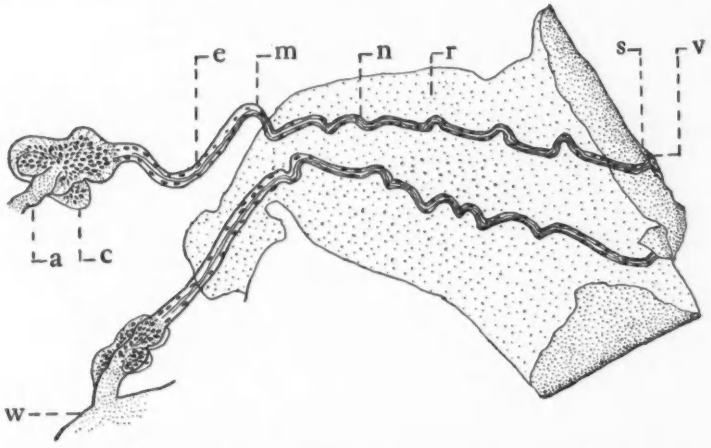

Fig. 1. The elongate pleuropodia in the embryo of the viviparous roach, *Diploptera dytiscoides*. a. The narrow connection to body wall. c. Enlargement of pleuropodium. e. Tubular portion of pleuropodium. m. The turn dorsalward. n. Main course to the micropylar area. r. Chorion. s. Vitelline membrane. v. Pleuropodium held between chorion and vitelline membrane. w. Body wall of embryo.

vitelline membrane (s). The dilatation of the upper pleuropodium is drawn in lateral view to reveal the extent of this area while the lower one presents a posterior aspect. Unfortunately, although the slide mount advantageously exposes different surfaces for examination, the tips of the pleuropodial extensions are broken off. The severed end of one is visible between the chorion and the vitelline membrane (v). To obtain a favorable orientation of these parts it was necessary to twist the upper pleuropodium between points *m* and *n*, but this artifact is omitted from the figure. The chorion (r) in the drawing lies above the posterior portions of the pleuropodia while the bases

of the latter have been bent away from the interior of the egg at *m* to permit observation. Neither of the embryonic envelopes exhibits any visible injury under the microscope following their puncture by the pleuropodia, quite in contrast to the situation in the Polyctenidae.

Those who have enjoyed Hussey's (1926) comprehensive summary of pleuropodia in hexapod embryos will at once realize that these pleuropodia are far longer than those of other insects. During their span of functional activity they measure nearly twice the length of the embryo. Pleuropodia are possessed by the embryos of many insects and embryologists have long sought for an explantaion of their persistence. Obviously they no longer survive to serve as locomotor organs but their continued presence and, at times, evidence of high physiological activity seem to predicate some necessary service to the embryo. Only recently the results of Slifer's (1937, 1938) carefully planned experiments on Orthoptera offer a partial solution of the problem. Her studies strongly support her contention that the pleuropodia of *Melanoplus differentialis* secrete the hatching enzymes necessary for the release of the embryo from the chorion of the egg when the hatching stage is attained. On the other hand, observations on the Polyctenidae and the roach, *Diploptera dytiscoides*, emphasize the probability that a nutritional function has been acquired by the pleuropodia of these species. If these conclusions are true, then at least two new services have been taken over by an obsolescent organ; duties that are totally unlike in scope and both wholly different from the original ambulatory function. Studies on the details of embryonic development of the roach, which are now in progress, should enable us to correlate the growth of the pleuropodia with that of the embryo, and with the egg yolk present prior to hatching.

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KEYS TO THE ORDERS OF IMMATURE STAGES (EXCLUSIVE OF EGGS AND PRONYMPHS) OF NORTH AMERICAN INSECTS

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For several years the writer has presented a course on immature insects dealing chiefly with the identification of nymphs, naiads, larvae and pupae. The following keys for the determination of insect orders have been used in this course. They had their beginning from incomplete keys prepared by A. D. MacGillivray when the author was a graduate student at the University of Illinois and have gradually evolved into their present form. They are published in their present state of development chiefly because, as far as known, no satisfactory published keys[1] exist in the English language for *all* of the common orders of immature insects of North America.

The keys presented here are doubtless far from perfect or exhaustive. They omit two orders of insects, namely, Zoraptera and Strepsiptera, if we accept the orders of insects listed in "An Introduction to Entomology" by J. H. Comstock, 1930, Comstock Publishing Co., Ithaca, N. Y., page 214. Also the author has not had an opportunity to see the immature stages of certain species in some of the insect orders, particularly among the Mecoptera and Siphonaptera. Furthermore it is probable that a number of unusual forms which have not been seen may occur among some of the orders. Undoubtedly species exist among these groups which cannot be determined by these keys. It is hoped that entomologists possessing material which cannot be identified correctly will call the author's attention to the difficulties involved and, if possible, furnish him with material which he may examine, so the keys may be changed to include these forms.

[1]Some literature containing partial or incomplete keys to orders of immature insects.

1. Classification of Insects, 1932, C. T. Brues and A. L. Melander. Bull. Mus. Comp. Zool., Harvard College, Cambridge, Mass., pages 28–38. Contains a combined key to orders for adults and immature stages. The immature stages of many species cannot be identified by this key.

2. Fresh-Water Biology, 1918, H. B. Ward and G. C. Whipple. John Wiley and Sons, New York City, page 917. Key to orders of aquatic insect larvae by J. G. Needham.

Those unfamiliar with terms used in the keys should consult "A Glossary of Entomology," by J. R. de la Torreo-Bueno, Brooklyn Ent. Soc., 1937. In using the keys one is directed to a specific number or a description is given of all or some members of an insect order. If a particular description of an order does not fit the specimen then one proceeds to the succeeding descriptions until a satisfactory descrption of an order is located.

The numbers on the margin within parentheses are useful in retracing major steps taken in the key. The key to larvae is so constructed that many species will fall into the proper insect order even though one may be uncertain about some of the major differentiations, especially the direction of the long axis of the head, or the presence or absence of a distinct head-capsule. In some of the orders the keys will not identify early instars of nymphs or larvae or early stages of pupae of some species.

In the preparation of the several unpublished revisions these keys have gone through during the past few years students and others have been very helpful in pointing out errors or inadequate descriptions. The writer is distinctly grateful for this constructive criticism and he hopes it will continue. The writer also wishes to build up a comprehensive student and reference collection of immature stages of insects, consequently he would like to receive interesting and unusual immature insects of all groups and also named economic species, especially from regions outside of Ohio.

KEY TO THE SUBCLASSES OF IMMATURE INSECTS

1. Mouth parts (mandibles and maxillae) of normal biting type, retracted within head among Collembola, Campodeidae and Japygidae; three pairs of legs present; tarsi frequently with two claws, never scansorial type; tarsi usually composed of one segment; wing rudiments always absent; sides of segments of the thorax larva-like; segments of the thorax not divided into smaller sclerites of pleura and sternum; abdomen may possess cerci, forceps or furcula and collophore, **APTERYGOTA—A**

2. Mouth parts not retracted within head when of the usual biting, rasping, or piercing and sucking types; if deeply retracted the mouth parts are usually claw-like (legless maggots) or of unusual sucking type (Anoplura, etc.); sclerotized mouth parts may be absent; legs ordinarily present; tarsi composed of one to five segments, when one segmented possessing only one claw; wing rudiments present in some orders, when present the sides of the thoracic segments and sterna are usually divided into smaller sclerites; all appendages absent among some larvae and puparia..... **PTERYGOTA—B**

A—KEY TO THE ORDERS OF IMMATURE APTERYGOTA

1. Antennae consisting of ten or more segments; cerci usually multiarticulate, long and filiform, or specialized into forcep-like structures; abdomen usually eleven segmented without a furcula or collophore; mesothorax never overlapping and concealing the prothorax, **Thysanura**

2. Antennae consisting of not more than eight segments; cerci never present nor specialized into forcep-like structures; abdomen six segmented, if segments are visible, and generally possesses a furcula, also a collophore may be present; mesothorax may overlap and conceal the small prothorax..... **Collembola**

B—KEY TO THE SUPERORDERS OF IMMATURE PTERYGOTA

1. A distinct head or jointed appendages (or both) present.....4

2. No jointed appendages or a well defined head-capsule present; sclerotized mouth parts absent or dissimilar to the generalized biting type typified by larvae of Lepidoptera or Coleoptera; body segments usually lightly sclerotized, concentric or flattened and in most cases light in color (shades of white or yellow); if spiracles are present on a thoracic segment (usually prothorax) or on a caudal segment (usually last) or on both then the body is apt to be straight and peg-like with head end pointed (maggots); if spiracles occur on most segments then body is apt to be U-shaped with mid-abdominal segments thicker than those at the ends (grubs); if spiracles are absent the body may be straight, spindle-shaped, or U-shaped (page 272), **LARVAE—ENDOPTERYGOTA**

3. External structure similar to that of straight, peg-like larvae or maggots (see 2) except the body length is shorter, the color (shades of yellow, red, brown or black) is darker, the body wall is harder and the shape is usually barrel-like; remanents of mouth-hooks, if present, are internal and usually invisible from exterior; caudal and thoracic spiracles usually present as remanents or scars; this larval exuvium (puparium) contains an exarate pupa or a larva (usually a hibernating form), (page 277)..... **PUPARIA—ENDOPTERYGOTA**

(1), 4. Mummy-like with all the appendages of future adult concealed individually in cases partially or completely visible; the legs (folded), wings (usually present), antennae, mouth parts and ovipositor (if present) are usually held close to the body in a fixed position, their cases may be fused to each other and to the body covering; the wing cases arise from the dorsal or lateral aspects of the thorax and project caudad and in most cases ventrad so that they cover a portion of the ventral aspect of the abdomen; the head may or may not be distinct; position of compound eyes usually visible, (page 277), **PUPAE—ENDOPTERYGOTA**

5. Not mummy-like in structure; all appendages free; legs, if present, movable, not in a fixed position; wing cases, if present, located entirely on dorsal or lateral aspects; head usually well defined with external (some exceptions), free and movable mouth parts; thoracic segments usually distinct; legs and wings may be absent.....6

6. Wing rudiments (pads) usually present, external, free and confined to dorsal or latero-dorsal aspects, never covering or projecting over ventral aspect; when wing pads are indistinct among aquatic naiads, two or three long tail-like cerci are usually present; thorax with all segments usually different in shape, sclerites of sternum and pleura usually distinct; compound eyes usually present, tarsi two to four segments, occasionally five, rarely one (scansorial type, etc.); legs rarely absent; shape of body usually resembles that of adult, (page 270)..... **NYMPHS AND NAIADS—EXOPTERYGOTA**

7. Wing rudiments invisible (internal only); all segments of thorax usually similar in shape (not size) and sclerites of sternum and pleura seldom distinct; compound eyes always absent; simple eyes may occur on the head-capsule near the mandibles and antennae; tarsi usually composed of one segment; legs may be absent; shape of body usually does not resemble that of adult, may be campodeiform, eruciform, scarabaeiform, vermiform, etc., (page 272), **LARVAE—ENDOPTERYGOTA**

KEY TO THE ORDERS OF NYMPHS AND NAIADS OF THE EXOPTERYGOTA

1. Mouth parts adapted for piercing and sucking or for piercing and rasping; piercing and sucking types show a distinct trough-like labium without palpi, enclosing needle-like mandibles and maxillae (see 22) or the labium is wanting and the short piercing stylets are retracted within the head-capsule along the meson (see 20); piercing and rasping type shows a distinct short cone-shaped structure (consisting of clypeus, labrum, maxillae, mandible and labium with maxillary and labial palpi) located between the head-capsule and the thorax on the ventral aspect (see 21)..... 19
2. Mouth parts adapted for chewing; the labium is exposed and not trough-like or cone-shaped; palpi of labium and maxillae rarely absent..... 3
3. Labium, when extended, usually four or more times as long as broad, scoop-like in structure and when folded (hinged between submentum and mentum) serves as a mask that covers the other mouth-parts; plate-like gills may occur at caudal end of abdomen; aquatic life, **Odonata**
4. Labium of normal type not modified into a scoop or hinged..... 5
5. Abdomen or thorax without tracheal gills, without long segmented tail-like filaments at caudal end; short ceric may exist..... 9
6. Tracheal gills (plate, feather, tassel or finger-like) usually occur on abdomen or thorax (none in some small Plecoptera, see 8); two or three, long, many segmented tails present at caudal end of abdomen; aquatic life..... 7
7. Tracheal gills (plate, feather, or tassel-like) located on lateral margins of abdominal tergites only; three tails (in some families only two), fringed with rather long setae, occur at caudal end; tarsi possess one claw..... **Ephemeroptera**
8. Tracheal gills, usually finger-like bunches or single, usually located on the ventral aspect of the thoracic segments, in some cases they occur on the jaws, on the proximal and on the last segments of the abdomen; (may be absent in Nemouridae and Capniidae); two distinct

tails (cerci), usually without long fringes of setae, occur at the caudal end of the abdomen; tarsi possess two claws.....**Plecoptera**

(5), 9. Antennae not more than 5-segmented; body strongly depressed (flattened); head larger and broader than prothorax; ectoparasitic life, **Mallophaga**

10. Antennae more than 5-segmented.....11

11. Prothorax usually subequal to mesothorax or metathorax or larger; if prothorax is much smaller than mesothorax or metathorax then cerci are present, tarsi are five jointed and the legs are greatly elongated...13

12. Prothorax shorter and smaller than mesothorax or metathorax; cerci wanting; tarsi two or three jointed; one jointed palpi on labium; resemble plant lice in shape.....**Corrodentia**

(11), 13. Long axis of head and mouth parts usually vertical; in one family (Blattidae) the mouth parts project caudad and in another family (Phasmidae) cephalo-ventrad; among the Phasmidae the prothorax is much smaller than the mesothorax or metathorax and the legs are greatly elongated; mouth parts for all species of a generalized biting type; antennae many segmented, long and usually located on the cephalic portion of the head capsule near the compound eyes, **Orthoptera**

14. Long axis of head and mouth parts project cephalad or cephalo-ventrad; the antennae usually located on the head capsule near the mandibles; compound eyes may be absent.....15

15. Head longer than broad, legs of moderate length and tarsi four segmented (frequently inconspicuous); color usually dirty white; exoskeleton frequently soft; ant-like in shape (called white ants); live within sapwood or dead wood.....**Isoptera**

16. Head distinctly broader than long; tarsi two or three segmented.....17

17. Proximal tarsal segments of prothoracic legs as long or longer than the tibia and strongly dilated (bearing openings to silk glands on ventral surface); proximal tarsal segments of other legs of normal size and shape.....**Embiidina**

18. Proximal tarsal segments of prothoracic legs not dilated nor do they differ greatly from the same segments of the other legs; forcep-like structures occur at caudal end of abdomen.....**Dermaptera**

(1), 19. Mouthparts (chiefly labium) external, visible and in form of a trough-like tube or a cone; wing rudiments usually visible.....21

20. Mouth parts internal, short piercing stylets withdrawn into head parallel with meson with no external labium; wing rudiments absent; tarsi scansorial type.....**Anoplura**

(19), 21. Mouth parts in form of a cone located between the ventro-caudal margin of the head and the prothorax showing maxillary palpi and inconspicuous labial palpi; mouth parts are assymmetrical in that only one functional mandible exists which may project a short distance from tip of mouth-cone; tarsi small, apparently one segmented, clawless and possess single, protrusile pads; body cylindrical, usually less than 1/8 inch long and pointed at caudal end.....**Thysanoptera**

22. Mandibles and maxillae (needle-like) usually enclosed within a trough-like tubular labium which usually projects caudad between the thoracic legs; labium may be absent, if labium is cone-shaped maxillary palpi and labial palpi are absent.....23

23. The mouth parts, consisting of a segmented labium enclosing needle-like mandibles and maxillae, arise from the cephalic portion of the ventral aspect of the head-capsule; in some aquatic species the mouth parts appear to rise from the caudal portion of the head-capsule; among these the legs usually show some kind of adaptation for aquatic locomotion and the prothoracic legs may be modified for grasping.....**Hemiptera**

24. The mouth parts, consisting of a labium (may be absent) and needle-like mandibles and maxillae, arise distinctly from the caudal portion of the head-capsule or from the meson between the thoracic legs; no aquatic species.....**Homoptera**

KEY TO THE ORDERS OF LARVAE OF ENDOPTERYGOTA

1. Thoracic legs absent (see 28) or represented by paired fleshy or cone-shaped swellings on mesothorax and metathorax or on all thoracic segments (see 24).....28 or 24

2. Segmented thoracic legs always present on two or all thoracic segments and usually possessing two or more segments with claws; in some species the legs are minute and inconspicuous.....3

3. Prolegs absent on abdominal segments one to eight, in rare cases prolegs occur on eighth segment.....9

4. Prolegs present on two or more abdominal segments.....5

5. Head usually with many (more than ten) simple eyes on each side, closely grouped; prolegs on abdominal segments one to eight or three to eight inclusive; anal end resembles a sucking disk.....**Mecoptera**

6. Head with never more than ten simple eyes on each side, generally less or wanting.....7

7. Prolegs usually present on abdominal segments three to six and last, may be absent on segments three, four or five; prolegs usually possess series of hooks (crochets) on distal ends; if crochets are present on abdominal segments prolegs are assumed to occur; simple eyes, when present, one to eight pairs, usually six; adfrontal areas usually present; antennae located in membranous areas at base of mandibles; spinneret present on labium, may be inconspicuous; spiracles usually present on prothorax and abdominal segments one to eight, most **Lepidoptera**

8. Prolegs usually present on segments two to eight and last, sometimes on two to seven or two to six and last; no crochets present; one pair of simple eyes usually present; no adfrontal areas; antennae usually arise from epicranium.....**Hymenoptera**

(3), 9. Prolegs absent on abdominal segments one to eight; one or two prolegs may occur on last segment or on what appears to be the eighth abdominal segment (Lymexylidae, Hylecoetus, etc.).....10

10. Head directed cephalad; the distance from the dorso-caudal margin of the head to the cephalic margin, including the labrum if present, equal to or slightly greater than the distance from the ventro-caudal margin of the head to the distal end of the labium; dorso-mesal line usually almost straight.....17

11. Head directed ventrad or cephalo-ventrad; the distance from the dorso-caudal margin of the head to the ventral (or cephalo-ventral) margin, including the labrum if present, much greater than the distance from the ventro-caudal margin of the head to the distal end of the labium; dorso-mesal line distinctly curved.....12

12. Head capsule may be deeply embedded in prothorax; may also possess adfrontal areas and several simple eyes; antennae arise from a membrane at the base of the mandibles; spinneret present; many species slug-like in form.....**Lepidoptera**

13. Head capsule not deeply embedded in prothorax and without adfrontal areas.....14

14. One pair of simple eyes present or absent; antennae arise from epicranium; thoracic legs usually straight or curved, not sharply elbowed beyond coxa; one or two pairs of spiracles on thorax (usually on prothorax and mesothorax) and several pairs on abdomen; body usually eruciform; anal cerci may be present.....**Hymenoptera**

15. Several pairs of simple eyes may be present; thoracic legs possess one claw and frequently are elbowed at two or more joints; proleg(s), without distinct hooks or crochets, may occur on the last or on what appears to be the next to the last abdominal segment; frequently mid-abdominal segments are enlarged or body is U-shaped; many setae may occur on thorax and abdomen; spiracles usually present on mesothorax and on eight abdominal segments; aquatic species possess gills on abdominal segments or the last segment(s) may be in form of a breathing tube.....**Coleoptera**

16. Several simple eyes in a close cluster usually present; legs on mesothorax and metathorax distinctly larger and project more laterad than legs on prothorax.....**Mecoptera**

(10), 17. Thoracic legs with one claw, stout spines about base of claw may create impression that two or more claws exist.....21

18. Thoracic legs with two distinct claws.....19

19. Mandibles and maxillae usually of normal biting type, rarely longer than the head; maxillary palpi and two segmented (usually) labial palpi present; mandibles may possess distinct ducts extending their entire length; labrum (and sometimes clypeus) invisible or partially concealed below cephalic margin of head; on the abdomen among terrestrial species urogomphi (cerci) usually occur on the ninth segment or dorsal spurs on the fifth segment, among aquatic species the caudal segment(s) may be tube-like or gills may be present...**Coleoptera**

20. Biting mouth parts conspicuous, especially the mandibles which may be long and sickle-shaped; labial palpi, when present, three or more segments; when the mandibles are united with the maxillae and show an internal duct extending the length of the jaws then maxillary palpi are absent; if the maxillae are free and possess palpi then a distinct labrum and clypeus exist; aquatic species may possess at caudal end of abdomen prolegs with hooks or a long, median, caudal, setiferous tail (tenth segment) may exist; also gills (sometimes segmented), spiracles and fleshy filaments may occur on most abdominal segments, most **Neuroptera**

(17), 21. Thoracic legs usually elbowed and may possess stout spines at base of claw; biting mouth parts and antennae of normal type, rarely longer than head; several (rarely one) pairs of simple eyes may be present; ventral prolegs (without hooks) and urogomphi may occur at caudal end of abdomen; head frequently depressed and always without adfrontal areas; spiracles usually present on mesothorax and on eight abdominal segments; aquatic species may possess abdominal gills or last segment(s) of abdomen may be tube-like..... **Coleoptera**

22. Single claws on thoracic legs with spurs on or about the base create the impression that two claws occur on some of the legs especially those on the mesothorax and metathorax; antennae and frequently maxillae absent or inconspicuous; mandibles small or of ordinary size; no prolegs except caudal grasping hooks; thoracic legs five segmented, trochanter frequently subdivided; gills may be present on thoracic and abdominal segments; larvae live in webs or cases in water.. **Trichoptera**

23. Single claws on thoracic legs; mandibles and maxillae long, piercing, slender structures that project cephalad; ventral respiratory filaments on seven abdominal segments; found in fresh-water sponges, Sisyridae of **Neuroptera**

(1), 24. Thoracic legs represented by unsegmented, fleshy, usually cone-shaped, paired protuberances called pedal lobes on two or three thoracic segments..... 25

25. Head distinct and directed ventrad or cephalo-ventrad; no adfrontal areas; simple eyes usually absent; body straight and of more or less uniform diameter throughout; usually two spiracles on thorax (prothorax and mesothorax) and several pairs on abdominal segments; a spine-like structure may occur on the dorso-caudal surface of the last abdominal segment..... **Hymenoptera**

26. Head distinct, usually directed ventrad or cephalo-ventrad; adfrontal areas, spinneret, one or more (usually six) pairs of simple eyes, prolegs with crochets on the third to sixth and last abdominal segments usually present; among Nepticulidae prolegs without crochets occur on abdominal segments two to seven..... **Lepidoptera**

27. Head distinct and directed cephalo-ventrad; ventro-lateral suture with hypopleurum of each abdominal segment distinct; body usually U-shaped with mid-abdominal segments of greater diameter than those near the caudal and cephalic ends, spiracles usually occur on mesothorax and abdominal segments..... **Coleoptera**

(1), 28. Segmented thoracic legs never present..... 29

29. Larvae with a distinct, sclerotized, pigmented, partial (caudal portion non-sclerotized or absent, see 34) or complete head-capsule (see 39), 34 or 39

30. Larvae without a distinct sclerotized head-capsule..... 31

31. Mouthparts may be reduced to a pair of opposable (or nearly so), sharp-pointed mandibles or to sclerotized plates fused with the cephalic segment or to more fleshy sensoria; larvae usually U-shaped, light in color, more or less pointed at both ends and larger in mid-region; inconspicuous spiracles usually present on one or two thoracic and five to seven abdominal segments; larvae are parasites of insects, live within plant tissues or live in cells or nests constructed by the adults, **Hymenoptera**

32. Mouth parts usually represented by one or two (usually distinctly parallel, not opposable), median, sclerotized, dark colored, decurved hook(s) usually embedded in the prothorax or cephalic segment; shape of many larvae spindle-like or peg-like with the cephalic end pointed and the caudal end blunt; abdomen usually eight or nine segments; pairs of spiracles may occur on the prothoracic segment and on the caudal or dorsal aspect of the last or next to the last abdominal segment; among aquatic species prolegs may occur on some or all abdominal segments and spiracles may be absent or replaced by gills or an elongated caudal, breathing tube or both. . **Diptera**

33. Mouth parts of some other type, usually greatly reduced and modified; abdomen may show ten segments; larvae may show a so-called "breast-bone" on ventro-meson of thorax; aquatic species may show one or several ventral prolegs and a caudal breathing tube or gills, **Diptera**

(29), 34. Mouth parts of normal biting type and antennae distinct. 37

35. Mouth parts highly modified, frequently reduced in size and structure or apparently absent. 36

36. Sclerotized head may be elongated, or flattened or reduced in area and frequently retracted into prothorax; pointed or hook-like mandibles, if present, usually assume a parallel position adjacent to a jointed labrum-epipharynx and between maxillae and appear to move dorso-ventrally; shape usually straight, frequently spindle-like; spiracles are absent or may occur on the prothorax and on a caudal segment or on all abdominal segments except the last (if unsatisfactory try 40 on) **Diptera**

(34), 37. Labrum a single lobe located between or covering proximal portions of the mandibles; some species show an enlarged prothorax and mesothorax; spiracles usually present on mesothorax and most abdominal segments; ambulatorial warts may occur on abdomen; many species live in wood. . . . . **Coleoptera**

38. Labrum and sometimes clypeus subdivided laterad into three parts with groups of setae or spines on the two lateral portions; head deeply retracted within prothorax; spiracles and gill-like structures may be present at caudal end; larval habitat aquatic or semi-aquatic. . . **Diptera**

(29), 39. Larvae with a distinct, somewhat pigmented, sclerotized head-capsule. . 40

40. Head-capsule directed distinctly cephalad (for more details read 10). . . . 47

41. Head-capsule directed ventrad or somewhat cephalo-ventrad (for more details read 11); if unsatisfactory try 47 to 52. 42

42. Larvae usually with one or more distinct cephalo-caudal folds or depressions on the lateral and ventro-lateral aspects of the abdominal segments; body somewhat U-shaped; mouth parts well developed and sclerotized, especially the mandibles; if simple eyes occur usually more than one pair; spiracles on the thorax (usually mesothorax) and abdominal segments fairly conspicuous; last segment of abdomen may possess a sclerotized dorsal plate with spines; most species live within or on plants. . . . . **Coleoptera**

43. Abdominal segments usually without distinct cephalo-caudal folds, depressions or sutures on the lateral or latero-ventral aspects. 44

44. Head-capsule rounded or depressed; adfrontal areas, spinneret, one or more (usually six) pairs of simple eyes and prolegs with crochets usually present.....**Lepidoptera**

45. Biting mouth parts (at least opposable mandibles) usually present but may not be heavily sclerotized; one pair of simple eyes may occur; thoracic and abdominal segments usually light colored and not heavily sclerotized; larvae may be pointed at one or both ends and U-shaped; inconspicuous spiracles usually present on one, two or three thoracic segments and most abdominal segments; larvae live within plant tissue, are parasites of insects or live in mud or paper-like cells constructed by the adults.....**Hymenoptera**

46. Larvae usually long and slender; in terrestrial forms spiracles may be present on prothorax or mesothorax and at the caudal end on one of the last three segments; if spiracles occur on several abdominal segments the caudal pair is much larger; mouth parts of biting type or reduced in size, some showing a median projection; aquatic species usually possess opposable biting mouth parts frequently with mouth-brushes; proleg(s) frequently on prothorax and occasionally on some of the abdominal segments; gills or a breathing tube at caudal end of abdomen.....**Diptera**

(40), 47. Head capsule peg-like, etc., variable in shape and size, not of usual round or depressed type.....52

48. Head capsule round type or depressed type.....49

49. Mouth parts opposable or parallel; abdomen usually with nine segments; cephalo-caudal folds or depressions may or may not occur on abdominal segments; spiracles usually occur on prothorax or mesothorax and at caudal end; when spiracles are present on most abdominal segments those on thorax and at caudal end of abdomen are larger than the remainder; rows of or scattered spine-like fleshy protuberances may occur on the abdomen and thorax; among aquatic species spiracles may be wanting, gill-like structures and (or) a breathing tube may occur at caudal end and proleg(s) at cephalic end or on a few abdominal segments.....**Diptera**

50. Abdomen with eleven, sclerotized, slender segments with no cephalo-caudal folds; spiracles inconspicuous, if present; several long setae on thoracic and abdominal segments; antennae and biting mouth parts present; total length under one-half inch.....**Siphonaptera**

51. Head rounded or depressed; biting mouth parts usually distinct; if head is depressed and mandibulate mouth parts are indistinct or absent then the cephalic margin of the head is irregularly serrated; abdomen with nine or ten segments which may be pigmented and distinctly sclerotized; spiracles usually present on mesothorax and most (usually eight) abdominal segments; body may be somewhat U-shaped.....**Coleoptera**

(47), 52. Head free or deeply retracted in prothorax, variable in shape and size, in some cases elongated, pointed and heavily sclerotized; among non-aquatic species caudal spiracles may be prominent on one of the last three abdominal segments; prothoracic spiracles may also occur; mouth parts not of usual biting type; among some aquatic or semi-aquatic species the mouth parts may be unusual and among others biting types exist which may possess brush-like modifications;

antennae may be prominent; prolegs may exist on the prothorax or on last abdominal segment or both or on several abdominal segments only; spiracles usually absent; gills may occur at the caudal end of the abdomen, last abdominal segment(s) may be elongated or a special breathing tube may exist.....**Diptera**

KEY TO THE ORDERS OF PUPAE AND PUPARIA OF THE ENDOPTERYGOTA

(In their late stages of development)

1. Appendages, including mouth parts, invisible on exterior (see 13) or, if visible, they are fused with each other and to the body wall to form a continuous covering; obtect type (see 14).....13 or 14
2. Appendages distinctly visible and free, even though held in a fixed position; resembles a mummy; exarate type (see note).....3
3. Body strongly compressed; length less than three mm.; wing pads absent; antennae minute; mandibles of piercing type; compound eyes absent.....**Siphonaptera**
4. Body rounded or flattened, not strongly compressed; antennae and wing rudiments usually prominent.....5
5. Mouth parts for biting and licking; mandibles present; usually a median or bifurcate lobe or tongue, the hypopharynx, arises from the labium; distal segments or ends of the twelve or more segmented antennae usually adjacent to and frequently parallel with the meson; paired ovipositors frequently visible at caudal end; a distinct constriction usually present between the thorax and abdomen, Most **Hymenoptera**
6. Mouth parts for biting *only*; no distinct tongue or paired ovipositors present.....7
7. Antennae long, always with twelve or more segments; wing rudiments not elytra-like.....9
8. Antennae shorter than the body, if elongated, with numerous stout segments and much longer than the body, usually eleven or less segments and distal segments usually far removed from meson; wing rudiments always elytra-like and located between the distal portion(s) of mesothoracic and metathoracic lges on the ventral aspect; legs elbowed sharply at end of femur.....most **Coleoptera**

(7), 9. Head abnormal in shape; head capsule and mouth parts elongated; antennae, with sixteen or more segments, arise from the head-capsule near the compound eyes and not from the beak as in some Rhyncophora.....**Mecoptera**

10. Head normal in shape; mouth parts not greatly elongated.....11
11. Mandibles large and stout never overlapping or crossing each other, most **Neuroptera**
12. Mandibles short, stout, curved, nearly cylindrical; they usually project cephalad or nearly so and cross each other; thorax and abdomen frequently bearing filamentous gills; usually found in cases or webs constructed by the larvae; Micropterygoidea of the Lepidoptera, non-aquatic and not over four mm. in length, may also fall into this group.....**Trichoptera**

NOTE.—Exarate pupae of aquatic or semi-aquatic species or within puparia possessing only one pair of wing cases belong to the Diptera.

(1), 13. All appendages invisible on exterior, the ectal surface smooth or made up of concentric rings, usually resembling a barrel with the two ends somewhat similar (blunt); caudal and thoracic spiracles of last larval stage usually visible as remanents or scars; this hardened or leathery larval exuvium (puparium) contains a pupa or a hibernating larva within, coarctate type.....Chiefly **Cyclorrhapha, Diptera**

(1), 14. The cases possessing the appendages of the developing adult visible on the lateral and ventral aspects of the thorax yet more or less fused to each other and in most instances to the body covering; obtect type.....15

15. Distinct respiratory projecting organs or breathing tubes present on the dorso-cephalic region; one pair of wings. Chiefly **Nemocera, Diptera**

16. Distinct respiratory projecting organs or breathing tubes absent on the dorso-cephalic region; spiracles usually present on mesothorax and some of the abdominal segments; functional mandibles absent except among Micropterygoidea, (see Trichoptera); paired galeae of maxillae usually present along ventro-meson; antennae adjacent to mesal margins of wings; two pairs of wings, outer pair may conceal inner pair.....most **Lepidoptera**

THE EMBRYOLOGY OF FLEAS by EDWARD L. KESSEL, 1939. Smithsonian Miscellaneous Collections, vol. 98, No. 3, pp. 1-78, 12 pls. SMITHSONIAN INSTITUTION, Washington, D. C.

Professor Kessel, of the University of San Francisco, San Francisco, California, is a post-graduate in zoology from the University of California where the finest of microscopical technique is taught. The research on the embryology of fleas was done by methods of double embedding which require extreme skill and great amounts of time. We recommend this volume for its detailed description of embryological technique of the highest order.

We recommend it again for its exceedingly clear exposition of an otherwise involved subject. It is more exactly paragraphed than any work we have read recently. Being on an embryological subject, dealing with undifferentiated material, we wonder if the text could possibly be more highly differentiated than was the material on which it is based. We doubt that such an error has crept in, but if so, it is better than the confused exposition so often put out hurriedly by many biologists.

The author makes no attempt to place the fleas phylogenetically by any characteristics of the embryology. Three species were studied one of which, *Hystrichopsylla dippei* Roths., a parasite of pack rats, Neotoma, is a giant in size and produces eggs 1.9 mm. in length. The three species represent three families.

The very exact technique producing perfect celloidin sections in series has permitted Professor Kessel to recognize the cleavage stages up to that (tenth) of 1024 cells. With this is a clear statement of the development of the pole cells and their final withdrawal into the gonads, and of the trophonuclei which are left in the yolk directly from cleavage stages.

Because the flea egg does not have stainable posterior granules which in other eggs are called germ cell determinants, the author suggests that this is evidence that the so-called germ cell determinants are not differentiators of the germ cells. The author suggests that the two dorsal organs formed out of the remains of amnion and serosa have the function of keeping probable waste matter in the amniotic fluid from penetrating the food supply of yolk. There is no distinct revolution of the embryo, though for a time the abdomen is sunk in the yolk. There are four malpighian tubules. In general the embryonic changes are normal and simple.—C. H. K.

NOTES AND NEW SPECIES: GRACILARIIDAE

(Microlepidoptera)

ANNETTE F. BRAUN,
2702 May St.,
Cincinnati, Ohio

Lithocolletis lucidicostella Clemens

Lithocolletis lucidicostella Clemens, Proc. Acad. Nat. Sci. Phila., 318, 1859.—Braun, Trans. Am. Ent. Soc., XXXIV, p. 281, 1908. (Rev. N. A. Spec. Lithocolletis.)

Specimens reared from mines on leaves of *Acer floridanum*, Washington Creek, near Burgaw, Pender County, North Carolina, differ from typical specimens of the species in the paler color and less extensive golden suffusion of the fore wing, with less sharply defined white costal and dorsal markings, the almost pure white hind wings and smaller size (the average expanse of these specimens is but little over 5 mm. as compared with the usual expanse of from 6.5 to 7 mm.).

Mines collected July 27, 1938; imagoes emerged August 2 to 9.

Lithocolletis crataegella Clemens

Lithocolletis crataegella Clemens, Proc. Acad. Nat. Sci. Phila., p. 324, 1859.—Braun, Trans. Am. Ent. Soc., XXXIV, p. 301, 1908. (Rev. N. A. Spec. Lithocolletis.)

A series of specimens reared on *Crataegus* in the Suislaw National Forest, near Florence, Lane County, Oregon, exhibits an unusually sharp definition of the white markings, with heavy black margining. The first dorsal streak is black-margined on both sides, with an accumulation of black scales on dorsum between it and the second dorsal, and along the middle of the wing. These specimens are also larger than typical eastern specimens, a feature of Pacific Northwest specimens of other species of the genus.

Mined leaves collected August 21, 1936, yielded imagoes from August 26 to 31.

Lithocolletis restrictella new species

Face and palpi silvery white, the latter shaded with fuscous outwardly; tuft on head white, more or less mixed with fuscous; antennae white, fuscous at tip. Thorax golden ochreous, with lateral and median white lines. Fore wings golden ochreous; a median longitudinal white streak from base to one-third, sometimes faintly dark-margined above; a short white streak along dorsum near base. The extreme costal

margin is dark brown from the base to the first white costal streak just before middle, the brown color here deflected to form its inner dark margin; opposite the first costal streak, a white, rather broadly triangular dorsal streak, not very oblique; the apices of this pair opposite. Beyond the first pair of streaks are three costal streaks, the last two often united, and two dorsal streaks, the first triangular with its apex a little beyond that of the corresponding costal streak; all the streaks dark-margined internally. An elongate patch of black scales in apex. Cilia whitish, with the marginal row of scales around apex blue-tipped. Hind wings and cilia grayish white, faintly tinged with ochreous. Underside of body and legs silvery white; anterior pair fuscous inwardly; middle and posterior pair very faintly tinged with fuscous at tips of segments. Expanse: 5.5 mm. to 6 mm.

Type.—♂, Allegany State Park, N. Y., reared from a miner of leaves of beech (*Fagus grandifolia*); imago August 15, 1938.

Paratypes.—3 ♂, 6 ♀, Allegany State Park, N. Y.; 5 ♂, 5 ♀, Kean County, Pa.; 2 ♀, Heart's Content, Warren County, Pa.; all reared on beech; dates of emergence of imagoes, August 4 to August 16.

Type and 15 paratypes in the author's collection; paratypes in the United States National Museum, Academy of Natural Sciences of Philadelphia, and Canadian National Collection.

Mined leaves were collected August 4, along State Highway No. 46 in Kean County, Pa.; August 5 in Allegany State Park, N. Y.; August 6, Heart's Content, Warren County, Pa. The elongate, tentiform, underside mine lies between two lateral veins, usually limited by them; and is very similar in aspect to that of *L. kearfottella* Braun on chestnut, except that at maturity the lower epidermis is thrown into a number of wrinkles, instead of the one characteristic of that species. The cocoon is loosely woven, very elongate, ovoid in shape and occupies about the middle third of the mine.

Distinguished from the other American species of its group (*crataegella* Clemens, *scuderella* F. & B., and others) by the less oblique first pair of streaks, especially by the more triangular dorsal streak. It is also separated from the European *L. faginella* Zeller by these same characters, as well as by its much smaller size.

The apparent northern distribution of *L. restrictella* seems strange in the face of the wide distribution of beech.

Lithocolletis ribefoliae new species

Face and palpi yellowish white, the latter fuscous outwardly; tuft on head mixed white, fuscous, and ochreous scales; antennae with basal segment and first few segments of the stalk white anteriorly, otherwise

fuscous. Thorax with faint median whitish line, and lateral whitish line continuous with the median basal streak of fore wing. Fore wings deep golden ochreous, more or less suffused with fuscous, and overlaid with fuscous scales, especially at base of costa, in the median apical third, and on dorsum. The median basal streak extends to two-fifths, indistinct at base, and unmargined. Four costal and two or three dorsal whitish or golden-suffused streaks. First pair before middle, very oblique, the dorsal long and narrow, its apex beyond that of the costal; second pair less oblique, the dorsal larger and more triangular and its apex beyond that of the costal; third costal nearer base than third dorsal which is often indistinct or absent; fourth costal just before apex. All the streaks inwardly dark-margined; the dark margining of the first two dorsal streaks heavy at the dorsum and conspicuous; the dark margin of the second confluent with the fuscous dusting in the middle of the wing. A patch of black scales at apex connects with the fuscous dusting. Cilia gray, pale golden near apex, with a dark bluish line of scales through the middle. Hind wings and cilia gray. Fore legs blackish outwardly, middle and hind legs silvery gray, with fuscous shading. Abdomen fuscous above, silvery beneath. Expanse: 7 to 7.5 mm.

Type.—♂, Del Norte Coast Redwood Grove, Del Norte County, California, reared from a miner of leaves of *Ribes* sp.; imago September 7, 1936.

Paratypes.—8 ♂, 2 ♀, same locality and rearing as above, imagoes August 31 to September 10; 3 ♀, near Siltcoos River, Douglas County, Oregon (on U. S. Highway 101), also reared on *Ribes* sp., imagoes August 30 to September 3, 1936.

Type and ten paratypes in the author's collection; paratypes in the United States National Museum, the Academy of Natural Sciences, and the California Academy of Sciences.

Mined leaves were collected at the Oregon locality on August 21; in California on August 23. The underside tent mine varies in extent depending on the texture of the leaf; on the thin leaves in the redwood forest the mine was large, occupying the major part of a leaf lobe; on the thicker-leaved Oregon *Ribes* the mines were rather small. The epidermis is irregularly wrinkled, the leaf substance eaten in patches, with a patch in the middle of the mine usually uneaten. The pupa lies in a silk-lined cavity beneath the uneaten patch; at emergence it is thrust through the upper epidermis.

This species is close to *L. scudderella* F. & B., but the dark dusting forming the inner margin of the dorsal streaks is always densest on the dorsum, never forming a heavy patch on the fold as in that species. The three Oregon specimens are a clear golden ochreous, with very little of the fuscous suffusion or dusting.

Lithocolletis holodisci new species

Face and palpi white, the latter dark fuscous outwardly; tuft on head mixed white and fuscous, with white hairs behind; antennae with the first few segments white anteriorly, rest fuscous. Thorax and fore wings pale fuscous ochreous, a lateral line on each side of thorax continuous with the indistinct unmargined pale median streak to one-third the wing length. Four costal and three dorsal curved whitish streaks, outwardly blending into the ground color, and inwardly narrowly margined with dark brown. First pair before middle, oblique, their apices meeting; the dorsal streak is the more oblique and on dorsum, lies nearer base than the costal; their internal dark margins meet at an acute angle. Second dorsal larger, more oblique than the curved second costal, its dark margin extending beyond that of the second costal. Third costal nearly opposite third dorsal; both nearly vertical. Fourth costal small, margined inwardly by a few brown scales; a few whitish scales opposite it on termen. A small dark brown patch of scales at apex. Cilia pale gray, whitish around apex, where the apical row of scales is narrowly fuscous-tipped. Hind wings and cilia pale gray with a faint golden tinge. Legs and underside of body pale silvery gray, tarsi of the fore pair broadly banded with dark fuscous. Expanse: 9 mm.

Type.—♂, Del Norte Coast Redwood Grove, Del Norte County, Cal., reared from a miner of leaves of *Holodiscus discolor*.

Type in the author's collection.

The mined leaves were collected August 23, 1936; the emergence of the imago escaped notice, so that no date of emergence is recorded. The larva is of the cylindrical group, but an upper side miner. The loosened epidermis is very thin and whitish, the mine roughly circular in outline; after the mine attains its full extent, and the larva ceases to be a sap-feeder, the epidermis is wrinkled and the parenchyma eaten. Pupation takes place in a silk-lined chamber above which the epidermis is more tightly wrinkled.

The mines occur commonly on the food plant, but are very heavily parasitized; a large collection from several localities yielded only the single specimen. In addition to the type locality, mines were collected at Lake Crescent, Olympic Peninsula, Washington, and in Lane County, Oregon.

This species is close to *L. scudderella* F. & B. and *L. ribefoliae* Braun (described above), but separated from both by the joining of the first pair of streaks and their margins; furthermore from *scudderella*, which it resembles in coloration, by the even, narrow margining of the first dorsal streak.

Lithocolletis memorabilis new species

Face and palpi leaden metallic; tuft of dark brown and golden hairs, antennae dark fuscous, becoming silvery toward tip. Thorax and fore

wings brilliant golden brown, with lustrous silvery or faintly golden markings. A short median basal streak in the fold to one-fifth, is dark margined at its tip, and just below its tip fuses with an ill-defined, golden-suffused pale dorsal spot placed at the basal fifth. Beyond the basal streak the ground color gradually deepens to the dark margin of an obtusely angulated somewhat irregular fascia at two-fifths. Beyond the fascia, are three costal and two dorsal silvery spots, all dark margined inwardly and more or less outwardly; the apex of the first dorsal spot lies opposite the space between the first and second costal. The apex of the third costal spot meets an elongate patch of silvery scales just preceding an irregular patch of black scales at apex. Cilia gray, golden tinged around apex; terminal row of scales around apex with blue-gray reflections. Hind wings and cilia dark gray. Legs gray, with silvery and golden reflections. Abdomen dark gray above, with golden reflections, paler beneath. Expanse: 9 to 10.5 mm.

Type.— ♂, Del Norte Coast Redwood Grove, Del Norte County, California, reared from a miner of leaves of *Lathyrus* sp.; imago, August 31, 1936.

Paratype.— ♀, same data as the type.

Type and paratype in the author's collection.

The mined leaves were collected August 23, 1936. The large tentiform underside mine has the loosened lower epidermis white and so much wrinkled at maturity that the leaf is closely rolled over. The mines were quite common on the few plants noticed, but most of the larvae were parasitized.

A very beautiful and distinct species, to be placed in the group with *L. viburnella* Braun and *L. diversella* Braun.

Lithocolletis fragilella F. & B.

Lithocolletis fragilella F. & B., Stett. ent. Zeit., XXXIX, p. 270, 1878.—Braun, Trans. Am. Ent. Soc., XXXIV, p. 315, 1908. (Rev. N. A. Spec. Lithocolletis.)

In a series reared on *Symphoricarpos* sp. from the lower slopes of the Grand Teton Mountains, Wyoming, the normal reddish ochreous ground color is partially (in one specimen almost completely) replaced by the extension of the fuscous-tipped scales which in the usual form margin the inner sides of the fasciae and spots. From mines collected July 30, 1934, moths emerged August 5 to 24.

Lithocolletis aberrans Braun

Lithocolletis aberrans Braun, Trans. Am. Ent. Soc., LVI, p. 12, 1930.

Further collecting has greatly extended the known range of this species (type locality, Adams County, Ohio). I now have reared specimens from eastern Kentucky (Perry County); Cumberland Falls, Kentucky; Mammoth Cave, Kentucky;

Shannon County, Missouri; Ozark National Forest, Stone County, Arkansas; and Fairfield County, South Carolina. Untenanted mines have also been noted in the Great Smoky Mountains, Tennessee. The earlier dates of these later collections of feeding larvae (late June and early July) and the July dates for emergence of the imagoes indicate two generations as usual in the genus.

Lithocolletis agrifoliella Braun

Lithocolletis agrifoliella Braun, Ent. News, XIX, p. 105, 1908.—Trans. Am. Ent. Soc., XXXIV, p. 331, 1908. (Rev. N. A. Spec. Lithocolletis.)

Four specimens, representing a summer generation of the species, reared on tan-oak (*Lithocarpus densiflora*), Upper Bull Creek Redwood Grove, Humboldt County, California, differ conspicuously from the type series, all of which are of the early spring generation. These specimens are much larger (11 to 12 mm. expanse), with paler ochreous ground color and clearer and more extensive white markings. The first pair of costal and dorsal streaks unite forming an obtusely angled white fascia; the second dorsal streak is broader (than in the type series), and meets the corresponding costal streak forming a second, acutely angled fascia. The two transverse black spots (basad of the first fascia) are distinctly edged with white scales basally. From the third costal streak a white line runs to the sickle-shaped streak above the dusted apex.

The mined leaves were collected August 24, 1936; imagoes emerged August 24 to 31.

Parectopa geraniella Braun

Parectopa geraniella Braun, Trans. Am. Ent. Soc., LXI, p. 51, 1935.

In addition to the type localities in Ohio and Kentucky, the species has been observed and reared in a number of the mountain counties of eastern Kentucky; also at Mammoth Cave, in western Kentucky, and in Shannon County, Missouri. It is thus apparently an Alleghenian and Ozarkian species. The habit of spinning the cocoon on the same leaf with the mine makes field recognition of the species certain.

Parectopa bumeliella new species

Head mouse gray; palpi white, outer side of second segment and outer and lower side of third segment of the labial palpi dark gray. Antennae gray, a white line on under side for about one-third the length, a similar line on upper side of first segment. Thorax and fore wings mouse gray, the latter with a faint coppery luster in some spec-

imens. This gray color shades gradually into orange in the apical fourth of the wing, leaving the margins of the gray ground color. In the apical fourth of the wing are four curved, outwardly concave white costal streaks, the last just before apex; opposite the first two of these, two more closely placed, but similar dorsal streaks. A circular black apical dot. Cilia gray, with a blackish line of scales through the middle from which at the apex, is emitted the blackish hair pencil; tips of cilia white below the hair pencil. Hind wings concolorous with the fore wings; greatly attenuated toward apex, but the veins present. Legs dark gray, longitudinally striped with white; a faint coppery luster on the femora. Abdomen gray, silvery beneath. Expanse: 5 to 7 mm.

Type.— ♀, Mammoth Cave, Kentucky, reared from a miner of leaves of *Bumelia lycioides;* imago July 4, 1937.

Paratypes.—3 ♂, 3 ♀, same locality and rearing as above, imagoes June 28 to July 3; 1 ♂, 2 ♀, Eureka Springs, Carroll County, Arkansas, reared on *Bumelia lanuginosa,* imagoes July 29 to August 2, 1938.

Type and seven paratypes in the author's collection; paratypes in the United States National Museum and the Academy of Natural Sciences.

The mines on *Bumelia lycioides* were collected June 13, 1937, near Mammoth Cave on the slopes above the Green River. The white upper side linear mine expands into a white blotch, usually obliterating the early mine; the blotch is roughly oval in outline, about 1 cm. by 1.5 cm. in area. The loosened epidermis is very thin; in the later feeding stages the entire loosened epidermis is thrown into a multitude of very fine wrinkles and the leaf slightly bent. Most of the parenchyma is consumed over the area of the mine. The cocoon is spun outside the mine in a crevice or slight fold of the leaf; it is pure white, much flattened. The mines on *Bumelia lanuginosa* were collected July 10, 1938, and represent a later generation, as earlier mines were observed at the same time.

An extremely inconspicuous species, not resembling any of the described species, but bearing a remarkable superficial resemblance in configuration of markings to some of the species of *Lyonetia.*

Gracilaria nondeterminata new species

Face pale ochreous, becoming darker above and shading to reddish with violet reflections on the head; palpi reddish ochreous, paler above. Antennae fuscous with paler annulations above, white beneath. Thorax and fore wings deep ochreous with rufous suffusion and showing violet reflections, especially toward apex. The coloration is much that of certain forms of *alnivorella.* In the allotype (♀) a longitudinal fuscous

streak extends through the wing from about the middle to the apex. Fore wings marked with a variable number of fuscous spots, of which the two most constant and characteristic are a rather large quadrate spot lying just above and contiguous to the fold at one-fourth, and a second similarly placed before the middle of the wing. Small fuscous spots on dorsum; a few minute dots on costa; a few small spots on disk of which one near end of fold may be conspicuous. Cilia of the ground color, tipped with dark purple-fuscous at apex, becoming gray toward dorsum. Hind wings and cilia gray with faint purplish and golden luster. Underside of both pairs of wings very dark; the fore wings clothed with blackish scales except at apex. Fore and middle legs clothed with ochreous or reddish brown and purplish fuscous scales, tarsi white with minutely darker tips. Hind legs, except for purplish fuscous femora, pale yellowish gray, with slight fuscous shading. Abdomen with gray, fuscous and reddish ochreous scaling. Expanse: 14.5 mm. (♀) to 17.5 mm. (♂).

Type.— ♂, near Siltcoos River, Douglas County, Oregon (on U. S. Highway 101), reared on *Ribes* sp.; imago September 10, 1936.

Allotype.— ♀, same locality and rearing; imago September 7, 1936.

Type and allotype in the author's collection.

The larvae were collected August 21. The squarish underside mine is but slightly wrinkled, with all parenchyma eaten. The first cone, made on leaving the mine, is small, and placed at the tip of one of the lobes; second cone much larger and of the usual *Gracilaria* form. Cocoon typical of the genus.

In general aspect, this species resembles some of the forms of *G. alnivorella* Chambers, but is at once distinguished by the different position of the most conspicuous of the fuscous spots.

I have not used Chambers' name, *ribesella*, given to a species which was observed by him in Colorado in the larval state only but has never been reared. Subsequent rearings from Chambers' locality can alone determine identity or non-identity of the two species. The insects described under the name, *Gracilaria ribesella* Chambers, by J. F. G. Clarke are specimens of *Zelleria gracilariella* Busck.

Gracilaria speciosella new species

Face and forehead lustrous pure white, shading through golden to deep purple fuscous on head; maxillary and labial palpi white, the maxillary faintly stained with fuscous, the apical third of labial, except extreme tip, dark brown. Antennae purple-fuscous, with narrow paler annulations. Thorax and fore wings lustrous crimson purple, with two golden costal marks. The first is a large, nearly equilateral triangle, reaching nearly or quite to dorsal margin, its base on costa from basal fourth to middle or beyond; its outer side is straight and a little longer

than the slightly convex inner side. Second costal mark nearly semicircular, reaching half way across the wing and distant on the costa from the first by one-half to one-quarter the width of the first. Beyond the second costal mark are two ill-defined costal and three dorsal dots, darker than the wing color. Cilia purplish fuscous, with three dark lines. Hind wings gray, with faint purplish and golden tints. Fore and middle legs dark brown; tarsi white, minutely tipped with brown; hind legs, except for the brown outer half of femora, yellowish white, tips of segments darker. Abdomen fuscous above, yellowish beneath. Expanse: 11 to 12 mm.

Type.—♂, Sardinia, Brown County, Ohio, reared on red maple (*Acer rubrum*); imago April 8, 1929.

Paratypes.—2 ♂, 2 ♀, of the same reared series as the type; 1 ♀, near London, Laurel County, Kentucky, also reared on red maple, imago April 8, 1934.

Type and four paratypes in the author's collection; one paratype in the United States National Museum.

The larvae were collected in October of the preceding year. The mine is a small transparent blotch, in its earliest linear stage an underside mine, situated in the angle at the base of one of the heavier veins; three cones are constructed, the first very small. Cocoon of the usual type.

This is the most brilliantly colored of the maple-feeding species. From *G. bimaculella* Ely, its nearest ally, it is separated by its broader wings, the more nearly equilateral costal triangle, the wider separation of the costal marks, and more brilliant color. From *G. amphidelta* Meyrick, it differs in color and in the separate veins M_2 and M_3 of the fore wings.

Gracilaria umbratella Braun

Gracilaria umbratella Braun, Can. Ent., LIX, p. 57, 1927.

Originally described from Ontario, later rearings have extended the known range of the species. Specimens from Mountain Lake, Giles County, Virginia, reared on red maple, and from Clifty Creek, Todd County, Kentucky, on sugar maple, agree with the type series in larval and cocoon-spinning habits and in imaginal characters.

Gracilaria superbifrontella Clemens

Gracilaria superbifrontella Clemens, Proc. Acad. Nat. Sci. Phila., p. 5, 1861.—Busck, Proc. Ent. Soc. Wash., V, p. 195, 1903.

A single specimen reared on *Hamamelis vernalis*, from Cass, Franklin County, Arkansas, exhibits a deep purple suffusion of the ground color, especially in the costal and apical areas, deeper than that in any eastern specimens I have seen. The locality record, from the western part of the Ozarks, is also of interest.

THE IMMATURE STAGES OF THE GENERA ONTHOLESTES, CREOPHILUS AND STAPHYLINUS

Staphylinidae (Coleoptera)

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The Genera herein considered contain the largest members of the *Staphylinidae*. The larvae are extremely large, heavily chitinized and usually dark brown in color. The head is well separated from the thorax; clypeo-labral margin dentate except at the close of the instar when the dentation becomes worn and obscure; legs of medium length, heavily armed; pseudopode long, cylindrical and used in locomotion; urogomphus usually more than twice as long as pseudopode, hair-like spines on the urogomphus are extremely long and usually are arranged in modified whorls.

KEY TO THE GENERA

Urogomphus not straight, apparently of one segment ..... **Ontholestes**
Urogomphus straight; of two segments .....
  First segment only slightly longer than second; spines few, in one whorl on first segment near its articulation with the second segment ..... **Creophilus**
  First segment long, much longer than pseudopode, sometimes bladder-like; spines in two or more whorls, whorls sometimes indistinct ..... **Staphylinus**

KEY TO THE KNOWN LARVAE OF THE GENUS STAPHYLINUS

1. Clypeo-labral margin distinctly dentate 2
   Clypeo-labral margin indistinctly dentate to smooth 4
2. Urogomphus bladder-like ..... **S. vulpinus**
   Urogomphus long, slender, spines arranged in whorls 3
3. Spines on posterior half of urogomphus arranged in three whorls .. **S. maculosus**
   Spines on posterior half of urogomphus arranged in two whorls ... **S. viridanus**
4. Urogomphus with spines on posterior half of first segment arranged in whorls, mature larvae large ..... **S. tomentosus**
   Urogomphus with spines on posterior half of first segment irregularly spaced, **S. comes**

[1]The major portion of this material was part of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate School of Indiana University. Contribution No. 243, (Entomological Series No. 11) from the Zoological Laboratories of Indiana University. Entomological Contribution No. 5, Department of Science, Southwest Missouri State Teachers College, Springfield, Missouri.

LARVAL AND PUPAL DESCRIPTIONS, STAPHYLININAE, SUBFAMILY DESCRIPTION

Egg. Oval to slightly egg shaped; surface granular to faintly striate; color creamy yellow to white; emergence may occur through a lengthwise slit or through an irregular opening.

Larva. Slender, fusiform; head and thorax more heavily chitinized than abdomen, color varies from very light testaceous to dark piceous brown, always darker anteriorly shading lighter posteriorly. Abdomen with heavy chitinous plates; plates dark in color; areas between plates very flexible and much lighter in color; composed of ten distinct segments with tenth segment (the pseudopode) long, cylindrical and used as an aid in locomotion; urogomphus usually biarticulate; abdomen varies in color from a milky white to a dirty brown, depending not only on the species but on the age of the larva, always lighter at the beginning of each instar.

Head parallel, hind angles rounded; smooth, shining and in many cases exhibiting a microscopically coriaseous appearance; neck well impressed, narrower than head. *Clypeo-labral* margin usually with nine distinct teeth, if not distinctly toothed an indication of the dentation will be shown by the setae on the anterior margin, in some cases the first and second clypeal teeth fuse so as to cause the margin to appear as if composed of seven teeth; the median labral tooth is shorter than the first lateral. The clypeo-labral margin bears eight setae, one on each side of the median tooth; one between the first lateral and the clypeal group; one between the first and second clypeal which is much longer than any of the others; and one on the inner margin of the third clypeal tooth midway between the base and apex. The setae of the clypeal group are present even if the median tooth is apparently lacking. *Ocelli* four except in *Quedius*. *Mandibles* simple, falcate. *Antennae* of four segments, located on the anterior margin of the head between the clypeus and the inner articulation of the mandible on a raised portion of the head sclerite; first segment short, truncate, base wider than apex; second segment longer than first, cylindrical, becoming globular near articulation with the third segment; third flattened, incrassate, to subtriangular, bears three long hair-like spines near its widest point; thumb on the inner surface of the third segment between the spines and the articulation with the fourth segment, basal half of thumb more heavily chitinized, apical half top-shaped, not heavily chitinized; fourth segment widest anteriorly, and near apex bears three long spines. Just anterior to these spines the segment suddenly constricts, segment tipped with four very short fine spines. *Maxillae* located on the ventral surface of the head, about the length of the cardo posterior to the inner articulation of the mandible; cardo short, cylindrical; stipes cylindrical, narrower and longer than cardo; mala slender, cylindrical, unarmed except for one or two very fine spines on apex; palpifer, short, never longer than wide, not uniformly chitinized, outer margin only slighted chitinized, as in the case of the outer anterior surface of the stipes, this allows the palps to be moved through an angle of more than 90 degrees. Maxillary palps of three or four segments. *Labium*

with mentum a truncated cone, slightly chitinized and very flexible allowing the prementum to be retracted. The demarcation of the mentum and prementum is not clear. Ventral surface of the prementum more heavily chitinized, this more heavily chitinized area extends onto the margins of the dorsal surface between the prementum and the palpigers; the dorsal surface of the prementum, palpigers and the ligula are covered with very small spines; palpigers not heavily chitinized; ligula conical. Labial palps of two or three segments. Spines below the mouth opening when present consist of a single row or rather long spines, their bases form one long or two short arcs. Spines above the mouth consist of two median confused groups and other spines between them and the mouth opening. Mouth opening varies in form from nearly a straight line to a rather sharp angle. *Gula* varies in shape from a slender nipple-shaped structure to a broad structure with the base triangular; the spines are arranged as follows: three lateral to the posterior angle of the mentum, one at the base of the triangular or nipple-shaped area and one midway between these two groups.

Thorax. Smooth shining; prothorax longer than wide, longer than the meso- or the metathorax but not longer than the meso- and metathorax combined; meso- and metathorax wider than long, subequal; color of thoracies grade lighter from anterior to posterior.

Legs. Rather slender, heavily armed on femur and tibia; well adapted for locomotion but not for rapid locomotion; coxa prominent, conical; tarsal claw single and may bear one or two short spines on its inner margin.

Abdomen with urogomphus usually biarticulate, (except in *Ontholestes* and *Quedius*), apex bears two spines, one very long spine on apex and one very short spine on inner angle of apex; pseudopode long cylindrical, not resembling the other abdominal segments.

Pupa. Compact; encased in a rigid, smooth, shining chitinous case which preserves its form after the insect emerges; color varies from a light testaceous to a dark rufo-testaceous, always growing darker with age; extremely uniform through the entire subfamily.

Ontholestes cingulatus (Gravenhorst)

(See Plate III, figs. 33, 34, 35, 37, 38, 39, 42, 43, 44, 45 and 49.)

Staphylinus cingulatus Gravenhorst, 1802, Col. Micr. Brunsv. 166.
Leistotrophus cingulatus Horn, 1878, Trans. Amer. Ent. Soc. 198, (in error, not *Leistotrophus* Perty, 1830, Delect. Anim. Art. Brazil 30. acc. Leng, 1920, Cat. Coleop. Amer. N. of Mexico, 109). Schaupp, 1879, Bull. Brooklyn Ent. Soc. 2: 30, larva and pupa. Beutenmuller, 1891, Jour. N. Y. Micro. Soc. 7: 7. Mank, 1923, Ann. Ent. Soc. Amer. 16: 234, fig. V, larva and pupa.
Ontholestes cingulatus Bernhauer & Schubert, 1914, Junk, Coleopterorum Catalogus pars 57: 392.

Egg. Oval, slightly longer than wide, creamy-yellow, smooth, with a slight granular appearance, not striate; no indication of a stalk; emergence opening irregular. Length 2.1 mm., width 1.4 mm.

Larva. Cylindrical; head and thorax dark brownish-rufous; abdomen dirty-brown. Length at hatching 6–10 mm., width 1–1.5 mm. Length of mature larva 15–25 mm., width 3–4 mm.

Head quadrate, posterior angles well rounded; distinctly coriaceous; exuviae brownish-rufous; frontal suture semicircular varying from slightly angulate to slightly flattened at point of union with epicranial suture; arms of gular suture forming an isosceles triangle with the base longer than the equal sides, gula reaching one-half distance to neck; posterior tentorial pit long, located more than own length posterior to tip of gula. *Clypeo-labral* margin with seven apparent teeth; median tooth short, one-third length of first lateral; clypeal group of two apparent teeth; in some the median area gives the appearance of a very flat tooth; tips of clypeal teeth forming an angle of 50° with the base. *Ocelli* with the second ocellus superior to first and third; fourth ventral and slightly posterior to third; first ocellus is much nearer third so as to give the group a very compact appearance; all subequal in size. *Antennae* with second segment twice as long as first; third nearly as long as second, narrow, less than one-third as wide as long, widest three-fourths anterior and sloping from widest point in both directions; thumb small; fourth segment slender, three-fifths as long as third, not as wide as base of third. *Maxillae* with stipes one-half longer than cardo; mala as long as palpifer; palpifer short, twice as wide as long; palps short stubby; first segment not as long as second, second slightly curved with spine on inner surface slightly posterior to middle and spine on outer surface near apex, third segment short and not as long as first segment. *Labium* with chitinous plates separating the posterior dorsal surface of palpigers from prementum wide and triangular; dorsal surface of prementum, palpigers and base of ligula densely covered with small spines; ligula two-thirds as long as first segment of palps, near apex on each side bearing a short hair-like spine. Labial palps of two segments; first segment twice as long as second, heavily chitinized except at anterior end, diameter greatest at anterior end; second segment short, conical and heavily chitinized. Spines below the mouth opening long with their bases forming almost a straight line. Spines above the mouth opening consisting of two confused groups and a few scattered spines between these groups and the mouth opening. Mouth opening forms almost a straight line.

Legs. Heavy, stubby, femur and tibia studded with many peg-like spines.

Abdomen with urogomphus apparently of a single long filament three times as long as pseudopode; anterior third armed with a large number of short irregularly arranged spines; posterior two-thirds bearing four equally spaced, extremely long spines; from the last spine to the tip twice the distance between other spines; urogomphus tipped at posterior end with a long spine and a very short spine on inner angle of tip; about half way between last spine and tip the chitin thins so that in some cast skins there appears to be a second segment to the urogomphus.

Pupa. Length 12–14 mm., width 4–4.5 mm.; anterior margin of prothorax bears from seven to nine pairs of hair-like spines, (the available material shows arrangements of 7-7, 7-8 and 7-9); lateral margins of eighth and ninth abdominal segments each bearing a rather short recurved spine; terminal segment bearing no spines.

The adults are attracted to dung and decaying fruits and vegetables. The larvae are found in similar habitats.

The larvae readily ate termites and broke open and ate the contents of large fly puparia. The material in my collection was all collected in dung. From two to three days previous to pupation the larvae encased themselves in nest-like cavities in the dung of the culture and unless disturbed pupation occurred within the cavity. One specimen which I disturbed destroyed the nest by twisting and turning and pupation occurred before a new nest was produced.

The length of the pupal period, in seven specimens, varied from ten to fourteen days. With two exceptions the larvae were all reared near where they were collected. One (culture No. 530) was collected at Douglass Lake, Michigan, and carried to Winona Lake, Indiana, where the temperature was higher than the locality of collection. A second individual (culture No. 362) was collected at Bass Lake, Indiana, and carried to the extreme southern portion of the state. In both cases the length of the pupal period was ten days. The differences are not as marked as in *Philonthus cruentatus* (Gmel.) (see Voris 1934) but it is indicative of the fact that higher temperatures shorten the length of the pupal period.

The material available for study includes three egg shells and one egg, fifteen larvae and larval exuviae on glass slides, a number of dry and alcoholic specimens of the larvae and pupae, six pupal exuviae and a number of dried nests. Immature forms have been collected at the following localities: Michigan: Douglass Lake. Indiana: Chesterton, Winona Lake and Bass Lake.

Creophilus maxillosus var. **villosus** (Gravenhorst)

(See Plate III, figs. 36, 40, 41, 46, 47 and 48.)

Staphylinus villosus Gravenhorst, 1802, Col. Micr. Brunsv. 160. Erichson, 1840, Genera et Species Coleopterorum, 349.
Creophilus villosus Nordmann, 1836, Symbolae ad Mon. Staphyl. 21. Horn, 1879, Trans. Amer. Ent. Soc. 7: 200. Talbot, 1928, The Ohio Jour. Sci. 28: 261, larva. Abbott, 1938, Jour. N. Y. Ent. Soc. 46: 49–53.
Creophilus maxillosus villosus Bernhauer & Schubert, 1914, Junk, Coleopterorum Catalogus pars 57: 399.

Egg. (acc. Abbott 38: 50). "Length, 2.0–3.0 mm.; width 1.5–2.0 mm.; ovoid, symmetrical, nearly prolate; opaque, white to cream; thin shelled; collapsing when preserved."

Larva. Cylindrical, stout; head and thorax dark rufous to piceous-brown; abdomen dirty-gray to brown. Length of mature larva 20.0–25.0 mm., width 2.5 3.5 mm.

Head subquadrate, slightly wider than long, hind angles well rounded and in immature larval forms the head approaches an oval outline; distinctly coriaceous; exuviae dark testaceous-brown; frontal suture semicircular, shallow, and may be very slightly flattened at point of union with epicranial suture; arms of gular suture forming an isosceles triangle with the base longer than the equal sides, equal sides sometimes concave, gula reaching two-thirds distance to neck; posterior tentorial pit located immediately posterior to the posterior tip of gula. *Clypeolabral* margin with nine prominent teeth; median tooth less than one-half length of first lateral; first lateral long prominent, conical and widely set from clypeal teeth; first and third clypeal teeth forming an angle of more than 45°. *Ocelli* with second ocellus superior to first and third, second nearer third than first, fourth ocellus ventral and slightly anterior to third; all forming a semicircle. *Antennae* with second segment twice as long as first; third segment three-fourths as long as second, two-fifths as wide as long, widest very near anterior end; thumb short, wider than long; fourth segment as long as width of third segment, as wide as base of third, nearly cylindrical, constriction so near anterior end as to appear abruptly cut off. *Maxillae* with stipes more than twice as long as cardomala small less than twice as long as palpifer; palpifer short, wider than long; palps composed of three segments, confluently short, stubby, segments decreasing in length anteriorly, first and second segments widest near anterior ends, spine on inner surface of second segment slightly anterior to middle, spine on outer surface of second segment near anterior end, third segment short, conical. *Labium* with band separating the dorsal half of the palpiger from the prementum rather wide, subtriangular; spines on dorsal surface sparsely covering all the slightly chitinized area of the prementum, palpigers and the posterior four-fifths of the ligula, spines on ligula longer anteriorly; palpigers globular, fleshy, prominent; ligula more than one-half length of first segment of palps. Labial palps of two segments; first segment long, widest anteriorly; second segment short, conical, one-third length of the first segment. Spines below mouth opening long, slender, with their bases forming almost a straight line. Spines above the mouth opening consisting of two median groups and a narrow scattered row of spines between these and the borders of the mouth opening. Mouth opening forming a long flat arc.

Legs. Heavy, stubby, femur and tibia studded with many peg-like spines.

Abdomen with urogomphus biarticulate, first segment of almost uniform diameter, bearing a few spines and constricted near posterior end, just anterior to constriction it bears a whorl of very long hair-like spines; second segment one-half as long as first, cylindrical, less than one-third the diameter of first, naked except for terminal spine.

Pupa. Length 11 mm., width 4 mm.; anterior margin of prothorax bears 11 to 13 pairs of hair-like spines (in the four specimens one has 11 pairs, two 12 pairs and one 13 pairs); lateral margins of the eight and ninth abdominal segments each bear a short, sharp recurved spine; terminal spines very short, bristle-like; female accessory spine absent.

The adults and the larvae are to be found around carrion and dumps containing large amounts of decaying matter.

The length of the pupal period is from twelve to fifteen days. The rearing was accomplished under a variety of circumstances so no conclusion can be drawn as to the length of the larval period. The larvae ate termites when they were placed in the culture.

My material includes five larvae reared to adults, preserved larval and pupal exuviae and a number of alcoholic specimens of larvae and pupae. The immature material was collected at the following localities: Michigan, Boyne City; Indiana: Dunes State Park and Winona Lake.

Staphylinus Linnaeus

Staphylinus Linnaeus, 1758, Syst. Nat. ed 10: 421, larva.

Egg. Known only in *Staphylinus maculosus.*

Larva. Cylindrical, head and thorax dark brownish-rufous to piceous-brown.

Head subquadrate, posterior angles well rounded; areas near gula, front and adjacent parts of the head coriaceous; frontal suture semicircular not flattened at point of union with epicranial suture; gular suture subtriangular to faintly nipple-shaped, basal portion of gula broad; posterior tentorial pit long. *Clypeo-labral* margin with nine subequal teeth, which may be so indistinct as to cause the margin to appear smooth but the setae clearly mark the position of the teeth. *Ocelli* four, arranged in one compact group. *Antennae* with third segment subtriangular, widest near anterior end; thumb small inconspicuous; fourth segment slender, tapering. *Maxillae* with palpifer no longer than wide, palps short, thick, composed of three segments, first cylindrical, globular at anterior end, second slightly curved, bearing one spine on inner surface and one on outer surface, third segment short, conical. *Labium* with the palpigers distinctly globular and prominent; prementum with anterior half conical, tapering to become confluent with the ligula, posterior half of prementum cylindrical, heavily chitinized area of ventral surface never extending to dorsal surface except for a narrow margin and a narrow tapering band between the prementum and the posterior half of the palpigers, dorsal surface densely covered with small spines as is the posterior two-thirds of the dorsal surface of the ligulae and palpigers; ligula long, conical; labial palps composed of two segments, first long cylindrical, enlarged at anterior end, second segment conical. Spines below the mouth opening arranged in one long row, spines long, slender, close set. Spines above the mouth opening arranged in two to four groups with scattered spines between them and the mouth opening. Mouth opening in the form of a straight line or flat arc.

Legs heavy, stubby; femur and tibia studded with many heavy peg-like spines.

Abdomen with urogomphus slender, biarticulate, or bladder-like; when of two segments, first segment long, narrow, fleshy, irregularly covered with very long hair-like spines; second segment short, cylindrical, naked except for two spines on tip, (one very long hair-like spine on tip and one small spine on inner angle of tip).

Pupa. Large, stout; spines on the anterior margin of the prothorax and the lateral margins of the eighth and ninth abdominal segments only; terminal segment naked.

Staphylinus vulpinus Nordmann

Staphylinus vulpinus Nordmann, 1837, Symb. Mon. Staph. 53. Schaupp, 1880, Bull. Brooklyn Ent. Soc. 3: 92, fig. 10 F., larva. Beutenmuller, 1891, Jour. N. Y. Micr. Soc. 7: 7.

Egg. Unknown.

Larva. (acc. Schaupp 80: 92) Length 18–20 mm.

Head oblong, sides nearly parallel, hind angles rounded. *Clypeo-labral* margin with five teeth, median small. (It is probable that the clypeal group is considered as a single tooth). *Antennae* with second segment longer than first, club-shaped; third segment three-fourths length of second, widest near anterior end; fourth one-half length of second. *Maxillae* with mala composed of two segments (this is not the case in the three species known to me); palps with first segment twice as long as palpifer, second segment shorter and more slender than first, third much shorter than second. *Labium* with first segment of palps one-third longer than second.

Abdomen with urogomphus bladder-like. This is a distinctive characteristic and does not correlate with the other species of the genus. During the summer of 1937 I collected one larva which was tentatively identified as *S. vulpinus* because of its size and bladder shaped urogomphus. The specimen died in culture and disintegrated so that it is useless for further comparisons.

Pupa. Undescribed.

Staphylinus maculosus Gravenhorst

(Plate I, figs. 1–16.)

Staphylinus maculosus Gravenhorst, 1802, Col. Micr. Brunsv. 165. Rathvon, 1861, Rep. U. S. Dept. Agric. 569, acc. Beutenmuller, 1891, 7: 7. Schaupp, 1878, Bull. Brooklyn Ent. Soc. 1: 42. Schaupp, 1879, Bull. Brooklyn Ent. Soc. 2: 30, larva.

Egg. Length 4.5 mm., width 3.0 mm.; oval; surface granular but not striate; emergence opening irregular.

Larva. One of the largest staphylinid larvae found in eastern North America. Length of mature larva 30–35 mm., width 3.2–3.4 mm.; length of larva at hatching 15–17 mm.

Head with gular suture subtriangular; posterior tip of posterior tentorial pit located lateral to posterior tip of gula. *Clypeo-labral* margin with teeth prominent, tips of teeth forming a rather smooth arc, median tooth only slightly shorter than first lateral; clypeal teeth forming an angle of 30°–35°. *Ocelli* subequal in diameter; second entirely superior

to line between first and third, second almost touching third; fourth ventral to third and as far from third as first is from second; first own diameter from third. *Antennae* with second segment twice as long as first; third four-fifths as long as second and less than one-third as wide as long, widest three-fourths anterior; thumb very short, not much longer than wide; fourth segment one-half as long as third, widest three-fourths anterior, not as wide as base of third; length of antenna in adult larva 2 mm. *Maxilla* with stipes two-thirds longer than cardo and with mala twice as long as palpifer, four times as long as wide; palpifer short. Maxillary palps with first segment shorter than second; second segment with spine on inner surface slightly anterior to middle, and spine on outer surface at anterior tip, third segment shorter than first. *Labium* with ligula two-thirds as long as first segment of palps. Spines below the mouth opening long, slender, close set with their bases forming almost a straight line and with the area between their bases and the submentum striate. Spines above the mouth opening consisting of two large median groups and a number of scattered spines between these groups and the mouth opening. Mouth opening forming a very slight arc.

Abdomen with urogomphus long; first segment twice as long as pseudopoda, spines of posterior half grouped in three whorls more than three-fourths length of second segment apart, spines of anterior half irregular; second segment less than one-fourth length of first segment; total length of urogomphus 4.5–5.0 mm.

Pupa. Length 12–14 mm., width 5–6 mm.; anterior margin of prothorax bears 10 to 11 pairs of hair-like spines, median pair small.

Both the larvae and adults feed readily under laboratory conditions and there is very little difference in their behavior. The habitat of the larva is no different from that of the adult. They are found near dung, carrion and decaying fungi; and in late fall and early spring they occur under logs, boards and other forms of protection.

I have fed to the larvae ant larvae and pupae, termites, and adult flies. When a number of termites were placed in the culture (culture No. 2) the larvae paralyzed (by crushing them in its mandibles) all those termites near it before it began to feed. In feeding, the larva picked up the termite and crushed it between its mandibles and clypeo-labral margin. Occasionally the prothoracic legs were used to turn the food or to help push the food back between the mandibles. As soon as the juices had been extracted the pellet was discarded and another piece of food picked up.

The available material includes twelve eggs and egg shells, sixteen larval exuviae, a number of preserved larvae, one pupal exuvia and one preserved pupa. The eggs with one exception are from one mated pair of adults and most of the larvae are from these eggs.

The material was collected at the following localities: Indiana: Winona Lake, Bloomington, Plainville. Michigan: South Haven. Kansas: Winfield.

Staphylinus viridanus Horn

(Plate II, figs. 17, 28 and 30.)

Staphylinus viridanus Horn, 1879, Trans. Amer. Ent. Soc. 7: 196.

Egg. Unknown.

Larva. Length 15–17 mm., width 2.0–2.5 mm.

Head with gular suture distinctly nipple-shaped; posterior tentorial pit located one-half of own length anterior to posterior tip of gula or midway between apex and base of nipple. *Clypeo-labral* margin with teeth prominent, tips of first laterals and clypeals forming a rather smooth arc; median labral very small, less than one-half length of first laterals; clypeal teeth all distinct, broad flat, entire margin forming a smooth curve. *Ocelli* subequal in diameter; second entirely superior to line between first and third, second almost touches first and third, first less than own diameter from third. *Antennae* with second segment twice as long as first; third two-thirds as long as second, one-third as wide as long, widest three-fourths anterior; thumb small, slender, slightly more than twice as long as wide; fourth segment not available for study. *Maxillae* with stipes two-thirds longer than cardo; mala as long as first segment of palps; palpifer very short. Maxillary palps with first segment shorter than second; spines of second segment and the entire third segment not clear in the preparations. *Labium* with ligula two-thirds as long as first segment of palps. Spines below the mouth opening long slender, close-set; their bases forming one long, flat arc. Spines above the mouth opening arranged in one large confused group. Widest at middle and tapering to each angle of the mouth opening. Mouth opening a long flat arc.

Abdomen with first segment of urogomphus from one-fourth to one-fifth longer than pseudopode; long spines on the posterior half of first segment arranged in two whorls, one whorl slightly posterior to middle of the segment and the other whorl just anterior to the articulation with the second segment; second segment two-fifths as long as first.

Pupa. Length 9 mm., width 3 mm.; anterior margin of prothorax bears seven to eight pairs of hair-like spines.

The descriptions are drawn from the exuviae of two larvae reared to adults and two preserved larvae which died in the cultures. They were all collected at Bloomington, Indiana, under decaying straw.

Staphylinus tomentosus Gravenhorst

(Plate II, figs. 18, 19, 20, 21, 25 and 32.)

Staphylinus tomentosus Gravenhorst, 1802, Col. Micr. Brunsv. 161. Horn, 1879, Trans. Amer. Ent. Soc. 7: 193.

Egg. Unknown.

Larva. Length of mature larva 20–22 mm.

Head with gular suture faintly nipple-shaped; posterior tentorial pit located own length anterior to the posterior tip of the gula. *Clypeo-labral* margin with teeth only faintly apparent, margin nearly smooth. *Ocelli* subequal in diameter; second ocellus entirely superior to and nearly touching first and third. *Antennae* with second segment twice as long as first; third short, broad, one-half as wide as long, three-fifths as long as second; thumb small, longer than wide; fourth segment two-thirds as long as third, not as wide as base of third; length of antenna 1 mm. *Maxillae* with stipes twice as long as cardo; mala three times as long as wide, one-half as long as first segment of palps; palpifer as wide as long; palps with first and third segments subequal in length, second slightly longer and bears on inner surface a small spine three-fourths anterior. *Labium* with ligula one-half length of first segment of palps; palps with first segment one-half longer than second. Spines below the mouth opening long, slender, thickly set with their bases forming a slight arc, area between their bases and the mentum not striate. Spines above the mouth opening composed of two groups extending from a median position towards the corners of the mouth with the basal portion appearing as if combed transversely with a coarse comb. Mouth opening in the form of a rather smooth arc.

Abdomen with first segment of urogomphus three times as long as pseudopode, spines on anterior half irregular, not forming whorls; spines on posterior half grouped in three whorls, whorls more than the length of the second segment apart; second segment one-eighth length of the first; length of the urogomphus 7 mm.

Pupa. Length 11.0–11.5 mm., width 4.0–4.2 mm.; anterior margin of prothorax bearing 7 to 8 pairs of hair-like spines.

The descriptions of the immature forms were taken from one larva reared to adult. The larval and pupal exuviae are in fair condition. The specimen was collected at Winona Lake, Indiana, on the lake shore under debris.

Staphylinus comes Leconte

(Plate II, figs. 22, 23, 24, 26, 27, 28 and 31.)

Staphylinus comes Leconte, 1863, Smiths. Misc. Coll. VI, 167: 36, acc. Leng, 1920, Cat. Coleop. Amer. N. of Mexico, 108. Horn, 1879, Trans. Amer. Ent. Soc. 7: 194.

Egg. Unknown.

Larva. Length 15–17 mm., width 1.3–1.7 mm.

Head with gular suture faintly nipple-shaped; posterior tentorial pit located slightly more than its own length anterior to posterior tip of gula. *Clypeo-labral* margin with teeth only faintly discernible. *Ocelli* indistinct as individuals. *Antennae* with second segment two and one-half times as long as first; third three-fourths as long as second, one-third as wide as long; thumb small nearly twice as long as wide; fourth segment two-thirds as long as third, not as wide as base of third; length of antenna 0.9 mm. *Maxillae* with stipes nearly twice as long as cardo; mala one-half as long as first segment of palps, three times as long as wide; palpifer one-third wider than long; palps with segments subequal

in length, spine on inner surface of second segment slightly anterior to middle, spine on outer surface of second segment near anterior end. *Labium* with ligula one-half length of first segment of palps; palps with first segment one-half longer than second. Spines below the mouth opening long, slender with the line formed by their bases slightly depressed at middle. Spines above the mouth opening consisting of two confused groups medianly placed and between them and the corners of mouth opening a small group with a few scattered spines between these groups and the mouth opening. Mouth opening well arched.

Abdomen with first segment of urogomphus two and one-half times as long as pseudopode, irregularly and sparsely covered with long spines, fewer on posterior half, those on posterior half not arranged in whorls; second segment one-eighth length of first segment.

Pupa. Length 6.3 mm., width 2.5 mm.; anterior margin of prothorax bearing 6 to 7 pairs of hair-like spines.

The descriptions of the immature stages were drawn from one larva reared to adult. The larval and pupal exuviae are both in good condition. The collection was made at Winfield, Kansas, in horse dung. The pupal stage lasted sixteen days and as the larva was not transported from that locality this probably represents the length of the pupal period of *S. comes* in southern Kansas in midsummer.

The determinations of all adults were either made or checked by Howard Notman.

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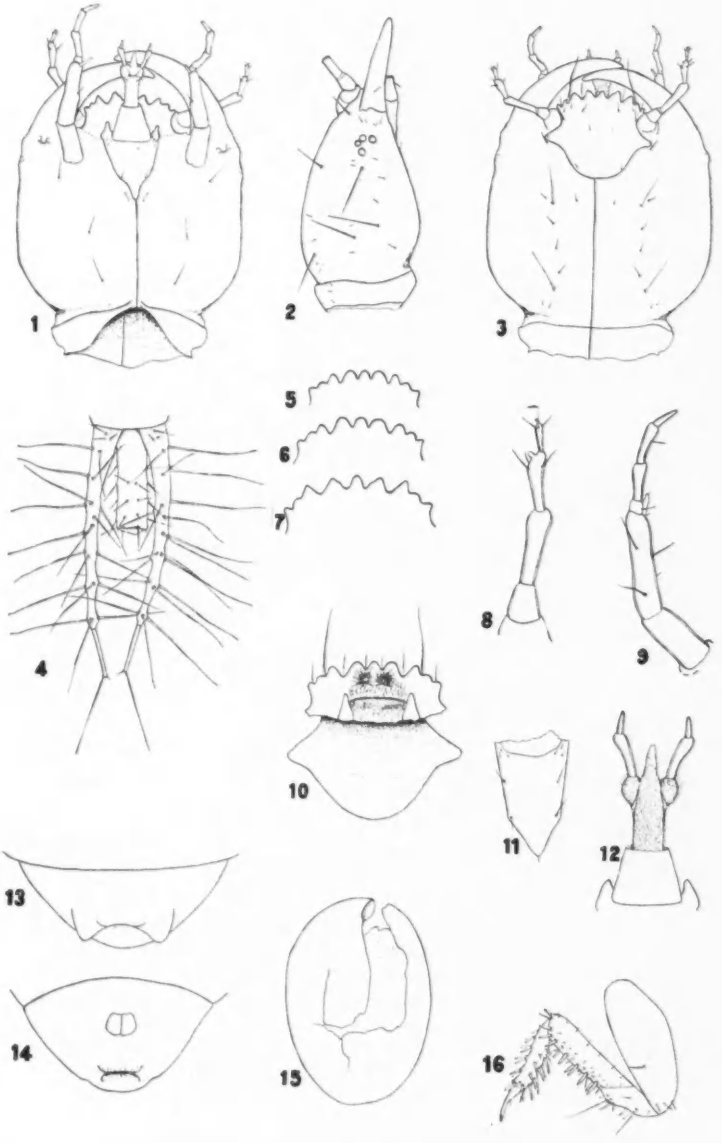
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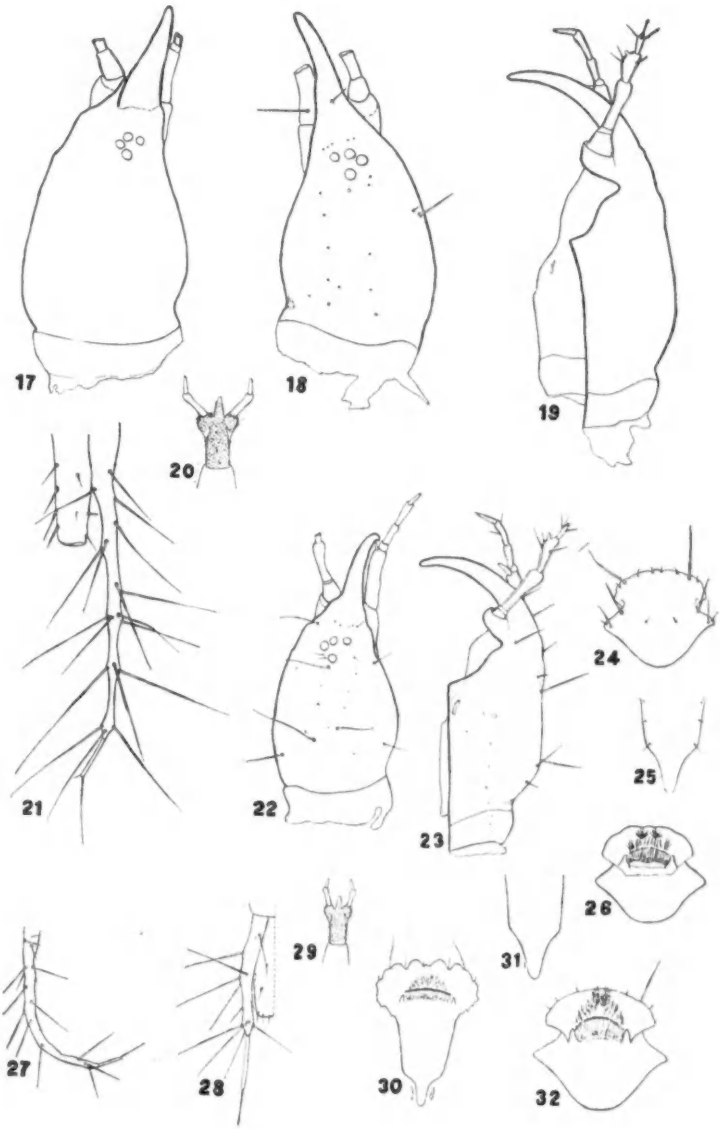
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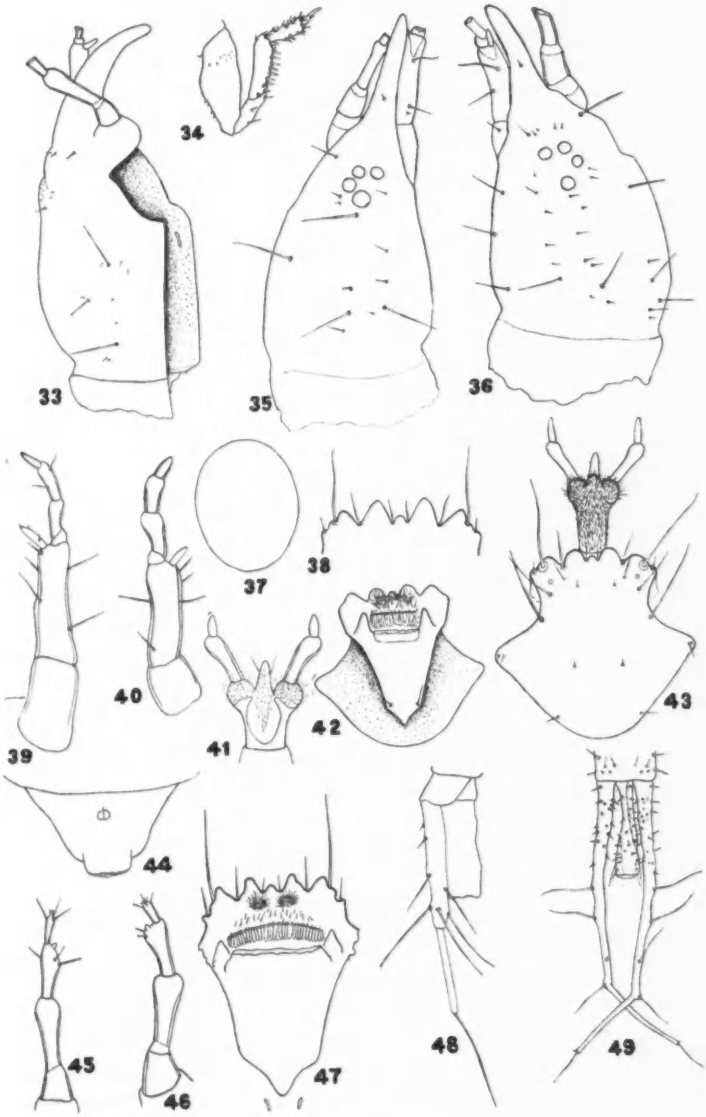
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OBSERVATIONS ON SOCIAL PARASITISM IN THE GENUS VESPULA THOMSON

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This paper presents some observations recently made on three nests of the yellow-jacket, *Vespula arenaria* (Fabricius) [=*diabolica* H. de Saussure], which had been parasitized by *Vespula adulterina* var. *arctica* Rohwer, and on a nest of *Vespula rufa* var. *vidua* (H. de Saussure), which had been invaded by a queen of *Vespula squamosa* (Drury), suspected of being a facultative, temporary social parasite. To this are added some remarks on the origin and evolution of social parasitism in the genus Vespula.

Parasitic relationships between members of the genus Vespula have been known through repeated observations made in the Palaearctic Region on *Vespula rufa* (Linnaeus) and its social parasite *Vespula austriaca* (Panzer). *V. austriaca* has also been found in the Nearctic Region, where varieties of *rufa* occur as well, but as yet there is no American record of their association. Fletcher (1908) found queens and males of *Vespula adulterina* var. *arctica* Rohwer living on friendly terms with *Vespula arenaria* (Fabricius) and the parasitic nature of the former was definitely confirmed later (Wheeler and Taylor, 1921). Neither *austriaca* nor *arctica* possesses a worker caste, and their fertile queens, unable to found colonies of their own, emerge from hibernation and invade the already established nests of their hosts, where they eventually supplant the true queen, while the workers of the invaded colony rear the brood of the parasite as their own. The parasitic brood develops into males and queens. Both the typical *V. adulterina* (R. du Buysson) and its variety *arctica* are parasites. The former occurs in the Palaearctic Region and in western North America, while the latter is found only in North America and is more common in the East. Bequaert (1932) reports that Professor H. A. Scullen in Oregon found two males of *adulterina* in a nest of *V. arenaria* var. *fernaldi* Lewis and further records the observation of M. Müller (reported by Bischoff), who caught a

female of *adulterina* as it flew out of a nest of *V. norwegica* (Fabricius) in Europe. The species *arenaria* and *norwegica* are so exceedingly close structurally that Bequaert (loc. cit.) is not sure that they are distinct. So far as I can learn these are all the recorded observations of the behavior of *adulterina* and its variety. I have been fortunate, then, to come upon three new nests of *arenaria* in different stages of development and parasitized by *arctica*.

1. VESPULA ARENARIA AND ITS PARASITE VESPULA ADULTERINA VAR. ARCTICA

On June 23, 1937, in the neighborhood of Civilian Conservation Corps Camp Woodbine, located east of Richwood, W. Va., in the Monongahela National Forest, I took a small nest of *Vespula arenaria* just before dark from its location under turf which overhung a roadside ditch. Half an hour earlier the workers had been entering and leaving the nest at a rate of not more than one a minute, but most had entered by the time the nest was taken. A little later I chloroformed the colony in order to examine it and found about 30 workers with their queen together with a queen of *arctica*. Both queens had been living, since they still moved their legs, but my efforts to keep the colony going were in vain, for the queens did not revive, and the few workers and immature forms which did survive the chloroform succumbed later. The nest contained three combs, the upper being 6.3 cm. in diameter, the middle one 5.7 cm., and the very small, lower comb containing but 14 cells. There were no large cells and there were no male nor queen pupae. This colony was obviously in a much earlier stage of development, so far as the parasite was concerned, than the one taken by Wheeler (Wheeler and Taylor, 1921) at Colebrook, Conn., on July 4, 1921. That one already contained 11 larvae of the parasite.

In early August of the same year (1937) I captured numerous males of *arctica* on flowers at Greer, Monongalia Co., W. Va. Hoping to locate the colony from which these had originated, I combed the immediate vicinity for several days without success. On August 13, however, I found a nest of *arenaria* under the overhanging turf of a roadside cut, about a mile from the place where the males had been taken. There is no reason to suppose that this nest, which was deserted, had produced the males, for I could not cover all of the densely wooded surroundings, and this had been a favorable year for yellow-jackets. The nest contained no living adults, and the larvae were also dead and badly dessicated or decayed. Several silk-capped cells indicated that pupae might still be living, and since I discovered three adult males of *arctica* lying dead between the combs, I took the nest for study. It contained three complete combs and the beginning of a fourth.

The first (uppermost) comb, with a diameter of 7.5 cm., contained small cells, the largest of which were about 5 mm. in diameter at the open end; centrally located were cells about 4 mm. wide. A few of the cells in this comb held the remains of larvae, but most of them had not

been occupied since the last adults had emerged from them. Some of the smaller, centrally located cells had been used twice; the larval exuviae and feces of the two broods could be readily seen on dissection. This comb contained six intact cocoons, from which small males of *arctica* later emerged.

The second comb (diameter 8 cm.) contained small cells, most of which were about 4 mm. wide at the open end. Disposed irregularly in an imperfect ring one to three cells wide and from three to four cells distant from the periphery were about 30 large cells, 6.5 mm. in diameter. Nearly all the cells of this comb, excepting the incompletely lengthened marginal ones, showed a torn silken cap—evidence of previous occupation—and nearly all were now occupied again by dead larvae and covered pupae. The latter were disposed as follows: two in the central seven cells; 15 in a ring three to four cells from the center; and six in the outermost row of full-length cells just outside the zone of large cells mentioned. The large cells had probably released queens of the parasite recently; from the smaller covered cells males of *arctica* later emerged.

In the third comb (diameter 6.5 cm.) all the cells with the exception of those in two or three peripheral rows were large, about 6.5 cm. in diameter. Two of these were capped, while the rest, crowned by recently broken silken coverings, were empty. The short peripheral cells contained a few dead larvae, their first occupants. From the two large capped cells two queens of *arctica* emerged later (August 16).

The fourth and lowest comb contained only seven small cells, each occupied by a dead larva.

This nest presents a satisfactory picture of the culmination of social parasitism in what would probably otherwise have been a prosperous colony for this species. It will be noted that not an individual of the host had survived, unless some or all of the dead larvae were proper inhabitants of the nest. This, however, appears somewhat doubtful, for all of the adults which later emerged were of the parasitic species and it is unlikely that the more recently produced young would be otherwise. It is always interesting to attempt to reconstruct the history of a yellow-jacket's nest from ruins like this. The facts gathered from a study of a nest at a given time coupled with known facts from other sources often lead to a better understanding of the life of a particular colony. We may assume that the life of a yellow-jacket from egg to adult is about 25 days, although this information, contributed by Janet (1903) was derived from his study of *Vespa crabro* Linnaeus, and may not be precisely accurate for other species. Since some of the cells of the present nest had been used twice, we must set the date of origin as early as June 24. In all probability it was before that date. The fact that most of the cells of the upper comb had been neither cleaned nor reoccupied since the emergence of the second brood, and the dried and decomposed state of all the larvae, suggest long absence of workers before the nest was taken. Invasion by the parasite, allowing the same time for development, must have occurred prior to July 19, only 25 days after the latest possible date of founding. Clearly a nest of this size must have been once populated by a much larger number of workers

than could have been produced by a queen which began her nest as late as June 24. It becomes necessary, therefore, to place the date of founding very early in June or late in May; the queen of *arctica* probably entered the nest before the middle of July, and may have lived, as in the nest taken by Wheeler (Wheeler and Taylor, 1921) and in the one described above, harmoniously with the queen of the host species for a time. It is obvious that the host queen disappeared some time before the death or departure of the queen of *arctica*, else there would have been workers of the host species found at the time of study.

A third nest of *V. arenaria* was taken on July 8, 1938, near Back Creek in Berkeley Co., W. Va., not far from the highway between Berkeley Springs and Martinsburg. Although I prefer to take nests at night, both for convenience and the certainty of obtaining most of the inhabitants, circumstances demanded that I get this by day. Workers were not flying in and out frequently, although the day was warm and bright. The nest was attached to the tip of a very slender branch about six feet above the ground, and the upper part of the envelope was securely fastened to a tuft of dead leaves left stranded there by the high water of a spring flood. The strips of paper making up the envelope were rather more irregular than usual, especially near the entrance, which was placed a little to one side of the vertical axis. The nest was 16 cm. high and 9 cm. in diameter. Within were 21 workers and seven males of *arenaria*, and a queen and 37 males of *arctica*. The parasitic queen was obviously the one which had invaded the nest and not a newly emerged virgin; her wings had the worn tips which characterize old queens. Possibly a dozen workers escaped or were killed during the taking of the nest (accomplished without anaesthetic) and some, but probably not many, were afield. There were three combs.

The first, or upper comb, was 6 cm. in diameter and was suspended from a single pedicel. Its central cell and two rows of cells surrounding it were occupied by eggs, frequently placed two in a cell. (Is this evidence of laying workers, as it is said to be in the honey bee?) Next to these was a row of covered cells containing pupae; this was followed by a row containing eggs with some larvae and pupae; finally the incompletely extended cells at the periphery contained larvae. Samples taken of the pupae proved to be *arctica* males, though one from near the middle was doubtfully so. The centrally located egg-containing cells had been previously used twice. The outer cells, with the exception of the short peripheral ones, had been used once before. This comb contained about 127 cells.

The middle comb of this nest was 5.5 cm. in diameter and contained approximately 91 cells. In the central cells were eggs and small larvae; the third and fourth rows of cells contained eggs; the fifth, eggs and some pupae; the sixth, pupae and a few larvae; and the incomplete outermost row contained pupae and larvae. Most of the pupae were males of *arctica*, but nine of them in the outer zone were queens of the same. The central egg-containing cells had been once used before their present occupancy.

The third comb measured 3.75 cm. in diameter and contained about 60 cells. The central cell and the six adjacent to it held pupae, which

were queens of *arctica;* the next row had some larvae among pupae of the same species; the fourth contained mostly larvae with some pupae, queens of *arctica;* and the incompletely lengthened outer rows held larvae exclusively.

We may rather definitely set the founding of this nest as early as the middle of May, which I believe is early for this species in most of W. Va., but probably not for the low portion lying east of the Alleghenies, where this nest was found. The presence of adult males of *arctica* places the invasion by the parasitic queen as early as June 13. The occurrence of males of the host may mean that the *arenaria* queen had vacated her nest before the invasion of *arctica*, leaving the egg-laying to her workers. On the other hand, I am inclined to believe that this species usually brings its relatively feeble colonies to maturity earlier than other species and that reproductive castes often appear early even in the presence of the queen. One nest which I took in Massachusetts on July 31, for example, contained the founding queen, one virgin queen, 247 workers, and 70 males. *Vespula arenaria* does not form large colonies, except possibly in the South, where Baerg's (1921) nest of 2070 adults is positively enormous, if, indeed, he had this species and not a more generally prolific one (see below). It is therefore not impossible that the two queens lived together for a time.

It is interesting to compare the results of social parasitism represented by my nest of August 13 with the condition of a normal colony of about the same age. On August 15, 1937, one of my students, Mr. A. W. Goddin, brought from Elkins, W. Va., a nest of *arenaria*, which he had carefully taken according to my directions. The founding queen was not discovered and I am reasonably certain that she had not been in the colony when it was captured. The population consisted of 65 virgin queens and 370 workers. In the cells were wasps in all stages, but a careful examination of many samples failed to reveal male pupae, or the presence of the dorsally placed oval testes which easily distinguish male larvae. An abundance of eggs was evidence of the recent activity of the queen or of laying workers. The nest was definitely aerial, as it was taken from under the eaves of a porch.

The first comb (8.3 x 6.3 cm.) contained irregularly zones arranged as follows from center to periphery: pupae, larvae, eggs, pupae, larvae, eggs, larvae. The larvae and pupae of this comb were all female, probably workers.

The second comb (12.1 x 7.6 cm.) contained the following sequence of zones: larvae, eggs, pupae, larvae, eggs, pupae, larvae. All of the pupae sampled were workers, as were probably the larvae.

The third comb (12.4 x 8.3 cm.) contained the following sequence: pupae, larvae, eggs, pupae, larvae. The outer zone of pupae was made up of queens. The sole male which later emerged from the nest probably came from the central group of pupae in this comb.

The fourth comb (9.5 x 6.3 cm.) contained the following sequence: pupae, larvae, eggs. The pupae were queens.

The fifth comb (3.8 x 3.2 cm.) contained only two larvae. There were no eggs, all other cells being empty. If laying workers had been responsible for the eggs found in the upper comb, why had these cells not been replenished?

For the sake of comparison, and to extend our knowledge of the populations of colonies of *Vespula arenaria*, I wish to record here some of my unpublished notes, which I small combine with data from the literature. It is possible (and in one instance certain) that some of these nests are of *V. norwegica* var. *norvegicoides* (Sladen). The two are distinguishable only with difficulty morphologically, and it is unlikely that their behavior differs notably.

TABLE I

SIZE OF COLONIES OF VESPULA, FROM AUTHOR'S NOTES AND FROM PUBLISHED RECORDS

Date	Locality	Founding ♀	Virgin ♀♀	♀♀	♂♂	Total Adults	Authority
June ?....	Calif....	0	0	39	0	39	Duncan, 1924
*June 23...	W. Va..	1	0	30+	0	30+	Taylor
*June 29...	Mass...	0	0	7	0	† 7	Wheeler and Taylor, 1921
July ?....	Oregon.	?	3	107	4	114	Duncan, 1924
*July 4....	Conn....	1	0	62	0	63	Wheeler and Taylor, 1921
*July 8....	W. Va..	0	0	31+	7	38+	Taylor
July 10...	Mass....	0	0	200+	0	200+	Taylor
July 21...	Conn....	0	0	76	0	76	Wheeler and Taylor, 1921
July 23...	Mass....	0	0	7	0	† 7	Taylor
July 24...	Mass....	0	0	75	24	99	Taylor
July 31...	Mass....	1	1	247	70	319	Taylor
July 31...	Mass....	0	0	78	0	78	Taylor
*Aug. 4....	Mass....	0	0	60	0	60	Taylor
Aug. 6....	Vt.....	1	0	50	0	51	Bequaert, 1932‡
Aug. 10...	Mass....	0	0	250	?	250	Taylor
*Aug. 13...	W. Va..	0	0	0	0	0	Taylor
Aug. 15...	W. Va..	0	65	365	0	430	Taylor
Aug. 23...	Ark.....	1 (?)	0 (?)	142	3	146	Baerg, 1921
Aug. 27...	Conn....	0	0	2	0	2	Wheeler and Taylor, 1921
Aug. 27...	Conn....	0	0	0	0	0	Wheeler and Taylor, 1921
Sept. 14..	Mass....	0	0	150	250	400	Wheeler and Taylor, 1921
Sept. 14..	Mass....	0	1	40	60	101	Wheeler and Taylor, 1921
Sept. 26..	Ark.....	?	294	1025	771	2090	Baerg, 1921

* Parasitized by *arctica*.
†Some escaped.
‡*V. norwegica* var. *norvegicoides*.

This tabulation of the populations of various nests on different dates and from widely separated localities emphasizes the point previously made (Wheeler and Taylor, 1921) that *V. arenaria* is particularly prone to the early loss of its queen, thus making it readily susceptible to invasion, though, as a matter of fact, the presence of a queen seems to be

no great obstacle to the parasite. It further shows that very small colonies are the rule in this species, the only exception being Baerg's colony of September 26 which approached a size reached in this country only by *V. vulgaris* (Linnaeus) and its near relatives. Baerg's statement about *V. arenaria* that "it is well known that these build a nest not unlike that of various species of Polistes; but locate it in the ground instead of in some shrub or tree," is puzzling, for as I have frequently noted, the nests of this species may be only a little above ground, on low shrubs or in some sheltered niche; or quite often above ground in a tree or on a building; but they are never underground (in Massachusetts or in West Virginia, at least) like those of *V. vulgaris*. The resemblance of any vespine nest to those of Polistes is certainly not very close, for the species of this genus build uncovered nests of single combs. If Baerg's nest was truly of *arenaria*, that species must have quite different habits and vastly greater reproductive capacity in Arkansas than elsewhere.

The information obtained from the three parasitized nests as well as from the other nests described and mentioned above confirms the conclusions which Wheeler and I drew in our former study. It is further brought out that the females of *arctica*, like those of the non-parasitic species are produced before the males. We may also conclude, what might have been predicted, that the ultimate result of social parasitism of *Vespula arenaria* by *Vespula adulterina* var. *arctica* is the complete extinction of the host colony. But this is also the regular course of events in normal colonies, and there is little reason for believing that the parasite hastens the end to a great extent, for the queens and males of the host in normal nests are produced at about the same time and in about the same numbers as those of the parasite. Indeed, the primary reproductive castes of all social insects are in a sense parasites on their own workers, and it is their ultimate preponderance over the workers—in yellow-jackets and in bumble-bees, at least—that contributes largely to the deterioration of the colony at the end of each season. But if the end is not markedly hastened by social parasitism of this sort, the reproductive capacity of the host colony is practically nullified by the apparently complete suppression of new queens. Presumably a small number of males is permitted, through the egg-laying propensities of the workers, to develop, but this is small compensation for a species which, through frequent loss of its founder queens, is predisposed to producing a superfluity of males and relativity few queens, if, indeed, it is fortunate enough to produce any of the latter. It is no small wonder that *V. arenaria* survives at all the hardships imposed by its own economy and the inroads of its parasite.

2. VESPULA RUFA VAR. VIDUA AND ITS SUSPECTED TEMPORARY PARASITE, VESPULA SQUAMOSA

On July 8, 1938, near Berkeley Springs, Morgan Co., W. Va., I collected a nest of a yellow-jacket within which was a queen readily identified as *Vespula squamosa* (Drury). As I had never seen the workers of this species, but recalled that they and the males are quite different from the queen, I assumed hastily that the nest belonged to *squamosa*, for the workers of this nest had little resemblance to the queen. Upon

examining the specimens a few weeks later I was astonished to find that the workers belonged to *Vespula rufa* var. *vidua* (H. de Saussure). Their identity and that of the *squamosa* queen have since been confirmed by Dr. Joseph Bequaert, who has also made valued comments on this discovery, but is in no way responsible for some of the interpretations which I have made. This nest was not underground, like other *vidua* nests which I have seen[1], but within a hollow and somewhat rotted log, which had been deposited on the banks of a small stream by flood waters. It was thoroughly dried out and the heart wood was quite soft. Entrance to the nest was through a small hole in the log about seven inches from the cavity in which the nest was suspended. The nest was of a peculiar shape, definitely flattened at both poles; it measured 3.5 cm. along the polar axis; its longest diameter through the equator was 6.3 cm.; its shortest equatorial diameter, perpendicular to this, was 5.7 cm. Whether this shape was made to conform to the cavity in the log or the latter had been hollowed out to fit the nest could not be decided. The envelope was of extremely thin and irregularly perforated paper, the individual strips of which were quite irregularly applied, though the whole was symmetrical. But one thickness covered the lower half of the nest while the upper half was constructed of three thicknesses, all imperfectly developed and apparently in the process of extension. In the lower half of the envelope were several perforations varying in diameter from about a millimeter to over a centimeter. The largest of these (1.1 x .8 cm.) had apparently served as an entrance; it was located half way between equator and lower pole on the side of the nest nearest the entrance to the log. The single comb, suspended from a single pedicel, contained about 115 cells. The contents of these were as follows:[2] 1st row, four cells containing eggs (one of them with two eggs); 2nd row, 10 cells containing two eggs, three larvae, and five cocoons; 3d row, 16 cells containing one egg and 15 larvae; 4th row, 22 cells containing 10 eggs, (two in one cell; one also in a cell with a larva), 10 larvae and four cocoons; 5th row, 28 cells containing 27 larvae and one cocoon; 6th row, 34 cells, containing six eggs and 28 larvae.

In the fourth row of cells were larvae of a parasite, as many as four of which occupied one cell. Some had spun cocoons, while others were feeding on the Vespula larvae. Later eight adults of the ichneumonid, *Sphecophaga burra* (Cresson), kindly identified for me by Mr. R. A. Cushman, emerged from the cocoons.

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[1]The following nests were all underground and all were taken at Forest Hills, Mass., in 1921. They were all of *vidua*, excepting the last, which was of the closely related var. *consobrina* (H. de Saussure). (1) July 21. Contained only 43 workers. (2) July 24. Contained the founder queen and 75 workers. (3) July 27. Contained the founder queen and 75 workers. (4) August 3. Contained 90 workers and 16 males.

[2]Following Janet (1903) who found that four cells are first made and that subsequent rows are built up on these, I have in this description designated the four central cells as the first row, the surrounding 10 cells the second row, the next ring of 16 cells the third row, etc. This practice was not followed in describing the previous nests, in which a single cell was considered to be first, followed by rings of 6, 12, 18, etc., cells successively.

The eggs in the first row and the two in the second row were third occupants of their cells. All the other cells of the second row, as well as those of the third and fourth rows had been once occupied before. The remaining cells of the comb harbored their first occupants. This would mean that the colony had already produced about 50 adults since its origin. At the time of taking this nest, I estimated the number of workers to be not more than 15; actually only about 10 were killed or captured while I was taking the nest. Since flights in and out were far from frequent, and very few workers appeared on the scene when I was working with the colony, I can hardly believe that there could have been more than 25 workers in all. This colony must have been founded about the middle of May. Unfortunately I was not aware of the possible significance of my discovery in time to take steps to keep the colony alive, but my facilities for this would have been scarcely adequate.

The question at once arises whether the presence of the *squamosa* queen in this nest of *vidua* was a mere accidental intrusion or an example of an unknown social relationship of some kind. It could hardly be true social parasitism of the obligatory type as practiced by *V. adulterina* and its variety *arctica*, for *squamosa* is known to have a worker caste, and so far as is known, is able to construct its own nests and carry its colonies to maturity. There are reasons, however, for not dismissing this occurrence as fortuitous.

(a) The *squamosa* queen was very obviously at home in the *vidua* nest, having been dislodged from the interior only after all the *vidua* workers had flown out. This is usually what happens when normal nests of Vespula are disturbed. A queen mother usually takes no part in the defense of a nest in which there are workers. A strange queen of another species would hardly be tolerated in a colony unless there was some biological relationship between the two. This is evidently the case with *arctica*, which, as shown above, is tolerated not only by the workers of the host, but for a time by the queen as well.

(b) *Vespula squamosa* and *V. rufa* var. *vidua* are closely related, both belonging to the subgroup of *V. rufa* (Bequaert, 1932). The two known social parasites in the genus are also closely related to their hosts.

(c) *Vespula rufa's* behavior is adapted to social parasitism, since it is the host of *V. austriaca*. It seems to me that this adaptation of the host to the parasite, which is often taken for granted, is fully as essential to the establishment of parasitic relationships among social insects as the adaptation of the parasite to the host. *V. rufa*, being accustomed to trophallactic exchanges with another related species, might more readily establish relationships with still another wasp than would a species in which this form of behavior had never been developed. This would seem to be particularly true of intolerant insects like the yellowjackets, well provided with adequate defense mechanisms and behavior.

(d) Queens of *squamosa* have been found flying in summer at a time when most species of Vespula have already established their nests and their queens have become restricted to the office of oviposition. This is true of the two queens taken and one other seen in W. Va.

(e) The nests of *squamosa* and of *vidua* are apparently built in similar places, according to the few records available. It seems to be generally true that species of the same subgroup are remarkably alike in their building habits.

These several circumstances support a view that the *Vespula squamosa* queen may on some occasions, or in some localities, invade an established nest of *V. rufa* var. *vidua* (or perhaps other varieties of the same species) and deposit its eggs. The brood from these eggs might then be reared by the *vidua* workers, and the host queen killed or ousted, as in the known cases of social parasitism in the genus. With the loss of the host queen the workers of *squamosa* would in time predominate and the *vidua* workers would die off. (According to Ritchie, 1915, the life of an adult worker of *Vespula vulgaris* is only three or four weeks.) The colony would then become indistinguishable from a colony established in the supposedly normal manner by *squamosa*. One would be tempted to wonder if the *squamosa* queen has lost its capacity for starting its own colonies, and is thus an obligatory temporary parasite, were it not for inequalities in the known distribution of the two species. Although the distributional data are far from complete, there are few and unreliable records of the occurrence of *vidua* or any of the other varieties of *rufa* in some of the Southern States where *squamosa* is presumably common. The fact that my own experience in West Virginia has been with queens of this species flying in summer, and that stray queens are found, according to Bequaert (1932) north of their usual nesting range leads to another speculation. It seems not altogether improbable that in the northern part of their range *squamosa* queens, habituated to early activity farther south, emerge from hibernation at a later date, and have become temporary parasites as an adaptation to a short season.

3. ORIGIN AND EVOLUTION OF SOCIAL PARASITISM IN VESPULA

If subsequent observations bear out the suspicion that *squamosa* is a facultative temporary parasite, they will furnish an important clue to the origin and evolution of social parasitism in the genus. It appears likely that *V. austriaca* and *V. adulterina*, on their way to becoming the obligatory permanent parasites that they now are, may have passed through a stage of facultative temporary parasitism such as I have postulated for *V. squamosa*. In this they would not be unlike other social parasites. In ants, as shown by Wheeler (1910, 1919) and others there are several grades of social parasitism. In the genus Vespula we may assume, I believe, that the social parasitism of *austriaca* and of *adulterina* corresponds to the permanent social parasitism of such workerless genera as Anergates, Wheeleriella, etc., while the suspected facultative temporary parasitism of *squamosa* has its counterpart in the temporary social parasitism found in the genus Formica. Similar conditions are to be discovered in the bumble-bees, where, as Plath (1934) has shown, *Bombus affinis* Cresson invades the nests and frequently becomes a temporary social parasite of *Bombus terricola* Kirby; and various species of Psythirus are obligatory permanent parasites of species of Bombus.

THE POSSIBLE PHYLOGENY OF SOCIAL PARASITISM IN VESPULA

On the basis of these facts and on our knowledge of the parasitic species of Vespula, as well as on the speculative inferences brought forth above, we may be permitted to construct a tentative scheme of the phylogeny of social parasitism in the genus, represented by four stages.

I. *Intra-specific, facultative temporary parasitism.* Queenless nests are invaded by queens of the same species. The invading queen is spared the labor of founding her own colony. Once the original workers have reared a sufficiently large number of the invading queen's progeny, they are replaced by it and the condition of parasitism ceases. Actual cases of this have been observed by Janet (1903) who discovered that the new queen was adopted by the workers. It may be of far more frequent occurrence than supposed. This sort of parasitism would scarcely be discovered excepting in colonies kept under constant observation.

II. *Inter-specific, facultative temporary parasitism.* Queenless nests are invaded by queens of different, but closely allied species. This stage might be expected in host species whose behavior has become adapted to tolerant acceptance of the first stage, and with parasites which may also have become accustomed to invasion of nests of their own kind. This is the suspected relation between *squamosa* and *vidua*. Here also, as in the first stage, the parasite becomes independent on the emergence of its own worker progeny. We should at a certain time expect to find mixed nests with workers of both species, but later such nests would lose all evidence of their parasitic origin. It is suggested that this type of parasitism might be resorted to when, as may be the case with *squamosa*, emergence from hibernation is delayed in northern ranges, and the internal stimulus to oviposition is so powerful as to provoke invasion. Indeed, the survival of the species in some localities may well be dependent on its modified behavior under some environmental conditions.

III. *Inter-specific, obligatory temporary parasitism.* The queen loses her ability to found her own nest but on being compelled to enter the nest of the host develops her own brood of workers, and the parasite becomes independent as in the previous stage. No instance or hint of this stage is known, but it seems a necessary transition to the final stage.

IV. *Inter-specific, obligatory permanent parasitism.* The worker caste becomes lost. This is the well established stage represented by *austriaca* and *adulterina*.

The dissimilarity in markings of the queen of *squamosa* on the one hand and of the male and worker on the other, and the lack of transitional sizes between workers and queens are unique in the Vespinae. I cannot avoid the belief that this has some significant relation to a special behavior pattern which only further study may reveal.

Admittedly it is essential to make many more observations on *Vespula squamosa* and on *Vespula rufa* and its several varieties before the validity of these speculations can be tested. The rarity of both species in W. Va. and the infrequency of good yellow-jacket years combine to prevent active prosecution of this problem. I would urge interested students to look into the nests of these species at every opportunity, not only for the solution of this problem, but for other facts that will add to our incomplete knowledge of these fascinating insects.

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IOWA STATE COLLEGE PRESS
Ames, Iowa

One of the difficulties in research entomology has been that of the publication of book-length manuscripts. Iowa State College has just taken over the "Collegiate Press" of Ames, Iowa, which was a successful private venture. The new "Iowa State College Press" is planned as an outlet in the fields of science and technology. It will accept suitable manuscripts from outside sources.—C. H. K.

DESCRIPTION OF A NEW MADAGASCAN LOPHOTILLA

(Hymenoptera: Mutillidae)

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The following new species of *Lophotilla* Bischoff was received in some material purchased from Prof. Ch. Lamberton of Madagascar. The unique type is retained in my collection.

Lophotilla tandrona[1] sp. nov.

Male.—13 mm. long. Black; pedicel of antenna, thorax entirely except sternum and lower portion of mesopleura, tegulae and narrow apical margins of abdominal tergites two to four inclusive, ferruginous. Clypeus with dense erect golden pubescence; front laterad of antennae and temples with appressed silvery pubescence; front with dense appressed golden pubescence; scape of antenna with sparse erect silvery pubescence. Pronotum and mesonotum with short subappressed golden bristles; scutellum and postscutellum with long erect golden pubescence; mesopleura and propodeum with long erect silvery hairs; sternum and legs with shorter erect silvery pubescence. Abdominal tergites one to four and the fifth tergite medianly with an apical fringe of appressed golden pubescence; spot of appressed golden pubescence near antero-lateral corners of second tergite, the remainder of that segment with appressed black pubescence; first, third and remaining tergites with erect silvery hairs laterally; sixth tergite with erect black pubescence; sternites sparsely clothed with subappressed silvery pubescence. Wings heavily infuscated.

Clypeal process triangular when viewed from above; viewed from in front there is a sulcus dividing two bracket-shaped processes, the arms of which extend laterad, thus:] [; mandibles deeply emarginate below at the anterior third; the inner tooth at the apex of the mandible is large and its apex forms almost a right angle; first segment of antennal flagellum moderately expanded, concave beneath and without a dense brush of erect pubescence; ocelli small.

Thorax, except propodeum, with large confluent punctures; scutellum convex and not produced conically; propodeum moderately and shallowly reticulate.

Last abdominal tergite slightly emarginate on the apical margin, the disk with a median longitudinal raised impunctate area which is slightly striate laterally; first sternite with a small tubercle anteriorly behind which is a median longitudinal keel extending to the posterior third of the segment; sixth sternite with an inconspicuous tubercle

[1]After the Tandrona, an aboriginal tribe of northwestern Madagascar.

laterally; seventh sternite with a low transverse sinuous carina anteriorly and a pair of recurved teeth near the apex.

Female.—Unknown.

Type.—♂, Maromandia, Region sêche, Madagascar N. W., May, 1938, (Ch. Lamberton.)

The Madagascan forms are separated from other species by the appressed golden pubescence of the abdomen. The species before me may be separated as follows:[2]

1. First abdominal sternite with a large median tooth near the base, the remainder of the segment without a median longitudinal keel; first segment of the antennal flagellum with a dense brush of long white pubescence beneath; scutellum somewhat conically produced; head and thorax entirely ferruginous; larger forms, 18–20 mm. long ..... **Betsilea** (Saussure)

   First abdominal sternite at most with a small tubercle near the base, armed with a median longitudinal keel on the basal half or two-thirds; first segment of antennal flagellum with short sparse pubescence beneath; scutellum convex, not conically produced; usually a portion of the head and thorax black; smaller forms, 10–15 mm. long 2

2. Second abdominal tergite without a pair of golden pubescent spots anteriorly, **Alluaudi** (Andre)

   Second abdominal tergite with a pair of golden pubescent spots anteriorly 3

3. Inner tooth near apex of mandible small and acutely angled apically; clypeal process consisting of two large separated divergent teeth; propodeum black; wings only slightly infumated; fifth abdominal tergite without appressed golden pubescence ..... **lobicornis** (Andre)

   Inner tooth of mandible large and forming almost a right angle at its apex; clypeal process triangular when viewed from above, and composed of two bracket-shaped processes divided by a sulcus when viewed from in front; propodeum ferruginous; wings heavily infuscated; fifth abdominal tergite with appressed golden pubescence medianly ..... **tandrona** sp. nov.

L. praeclara Bischoff[3] is the only Madagascan species not before me. Bischoff separates it from all but *L. Betsilea* (Sauss.) by the ferruginous head and thorax, and from *Betsilea* by the polished median area of the scutellum and the golden pubescence on the second abdominal tergite which covers the entire basal half of the segment.

[2]The females of this genus are unknown.

[3]Arch. f. Naturges., LXXXVI, Abt. A, Heft 2: 311, 1920.

AQUATIC INSECTS by JOHN CLEGG. Thirty pages with about 30 text figs., 5.5x8.5 inches, paper cover, stapled. (No. 6 of "Water Life Series"). Published by THE MARSHALL PRESS, LTD., 7 Milford Lane, Strand, London, W. C. 2, England. Price by post 7 d. (15 cents).

This is a pamphlet for aquarium lovers. It is one of a series, the others of which have the following titles: "First Steps in Aquarium Keeping," "Hardy Reptiles and Amphibians for the Amateur," "Land and Water Tortoises," Live Foods for Aquarium Fishes" and "First Steps in Pond Keeping."

The eight chapters cover the main groups of palearctic aquatic insects with enough good text figures to permit the user of the guide to identify them to their proper groups.

"Water Life" is a weekly paper on aquiculture mainly for the owners of household aquaria; "Price threepence every Tuesday."—C. H. K.

THE LIFE-CYCLE AND BIONOMICS OF LIPEURUS CAPONIS (LINN.)

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It has seemed since the publication by the writer of the life-cycle of *Lipeurus heterographus* Nitzsch that similar work on other species of poultry lice would be desirable. These species are readily available for experimental work and it would appear that much could be gained by concentrating on the lice of one host, not only because of the economic value of the domestic fowl, but also to develop the picture of a single host in its relationship to all of its mallophagan parasites.

Males and females of *Lipeurus caponis* (Linn.) of unknown age were collected from fowls in New Orleans, La., on August 27, 1937. A male and a female were placed on a feather in each of several syracuse watch glasses and these placed in an incubator. The same technique was followed as described in the work on *Lipeurus heterographus* Nitzsch (Wilson 1934). The watch glasses were examined daily and if eggs were found, the adults were removed to another watch glass. The temperature of the incubator was maintained at 32°–33° C. although for one day, October 12, it rose to 38° C. and on October 13 it dropped to 26° C.

THE LIFE CYCLE

Adults were reared from eggs laid by the females of pairs number 2 and 3.

The male of pair number 2 died on Sept. 9, having lived in the incubator 13 days. The female died on Sept. 19, having lived in the incubator 23 days and having laid 30 eggs. The eggs were laid on 19 different days. On one day 3 eggs were laid, 2 eggs were laid on each of 7 days. On other days only one egg was found. Six eggs were laid after the death of the male. The last egg that hatched was laid 5 days after the death of the male.

The male of pair number 3 died on August 28, having lived only one day in the incubator. The female died on Sept. 30, having lived in the incubator 34 days and laid 35 eggs. Three eggs were laid on each of 2 days. Two eggs were laid on each of 10 days and the others were laid one a day. On some days, of course, no eggs were laid. At least 33 of the 35 eggs were laid after the death of the male. The last egg that hatched was laid 30 days after the male died.

Sixty of the above eggs hatched in 4–7 days. Three hatched in 4 days, twenty-five required 5 days, twenty-nine required 6 days and three required 7 days.

Twenty of the sixty first instar young molted to the second instar. In these the first instar lasted from 6–18 days. Four required 6 days, three required 7 days, three required 8 days, one required 9 days, two required 10 days, four required 11 days, one required 14 days, one required 15 days and one required 18 days.

Seven of the twenty which reached the second instar molted to the third instar. One required 5 days, one required 6 days, one required 7 days, one required 8 days, two required 9 days and one 16 days.

Three of the seven reaching the third instar molted to become adults. One required 6 days, one required 7 days, and one required 9 days. The time elapsed from hatching to the emergence of these adults was 18, 23 and 27 days.

RECOGNITION OF NYMPHAL INSTARS

The instars are easily recognized by the head measurements given below for three individuals of each nymphal instar and by the hairs in the postero-lateral angles of the metathorax.

First Instars

Head length	.369 mm.	.330 mm.	.343 mm.
Head width across temples	.262 mm.	.211 mm.	.223 mm.

There is a single hair in each postero-lateral angle of the metathorax.

Second Instars

Head length	.396 mm.	.383 mm.	.396 mm.
Head width across temples	.264 mm.	.277 mm.	.251 mm.

There is a group of three hairs in a clear area and a single hair in each postero-lateral angle of the metathorax. One individual was asymmetrical for this character, having a group of four hairs and a single hair in one postero-lateral angle of the metathorax.

Third Instars

Head length	.462 mm.	.442 mm.	.501 mm.
Head width across temples	.303 mm.	.277 mm.	.290 mm.

The clear area in each postero-lateral angle of the metathorax contains four hairs and there is a single hair near the lateral margin.

DISCUSSION

The high mortality of the young stands out as a result of these experiments, and causes some apprehension that incubator conditions might not have been ideal either in temperature or in the humidity. It is also possible that some occasional food substance other than feather is required or that there were disease organisms present. The greatest death rate occurred within a few days after hatching and there were some indications that many died due to inability to free themselves from the old exuviae.

Copulation was not observed although unsuccessful attempts were seen suggesting the same technique as described by the writer in his study of *Lipeurus heterographus* Nitzsch. The fact that a female laid fertile eggs as late as 30 days after the death of her male partner would suggest that copulation was not necessarily of frequent occurrence. It is even possible that after a successful mating a female is fertile for life.

Copulation is not a necessary stimulant for egg laying. A third instar of unknown age was collected from a fowl. Mistaken for a female, it was placed on a feather in a watch glass with a male. The male was dead the next day and three days after the death of the male, the third instar molted and emerged as a female. She was kept on the feather without a male. Four days after her appearance as an adult three eggs were found on the feather and these were added to in the next sixteen days until a total of fifteen eggs were laid. None of these eggs hatched. The female lived as an adult for thirty six days.

The segmentation of the abdomen of the nymphs is the same as that described for *Lipeurus heterographus* Nitzsch (Wilson 1936). The nine-segmented condition of the adults appears to be due to a fusion of the true first and second abdominal segments and a fusion of the true ninth and tenth abdominal segments.

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A LABORATORY INTRODUCTION TO ANIMAL ECOLOGY AND TAXONOMY by ORLANDO PARK, W. C. ALLEE and V. E. SHELFORD. Pages 1–272. 6.25x8.5 inches, scattered illustrations, 1939. Linen bound with ringed back. Published by THE UNIVERSITY OF CHICAGO PRESS, 5750 Ellis Avenue, Chicago, Ill. Price $2.00.

This is a "loose leaf" laboratory guide with keys, laboratory instructions and questions for observation and verification on the material before the student. It is justified in the "Foreword" by Allee as follows: "In the study of field zoology, observations in nature are, of course, primary and irreplaceable. Field experiences, however, can be greatly enriched by the more careful studies which are usually possible only in a laboratory; and both can be illuminated by reading the work and conclusions of others. Such periods of inside study send the interested student out into the field again bristling with questions which can only be answered by observations made under natural conditions."

The work opens with twenty-two pages on ecological principles. Following this general discussion of the interrelation of animals with their environments are about thirty-five laboratory exercises. Some of these are on pillbugs, on ants, on termites, tiger beetles, ant lions, aphids, snails, hydra, sponges, etc. Pages 129–194 are keys to the orders of animals; pages 197–210, glossary; 213–257, bibliography; then a subject index and a taxonomic index.

The volume is based on laboratory directions which have already had hard tryouts (over thirty years) in the laboratories of the three authors. The latest workout has been given them in the laboratory of Orlando Park at Northwestern University. With the standing of the three authors in the science of animal ecology we think of this guide as being probably the best in its field. The laboratory exercises certainly ask the students many intimate questions on the private life of the many animals studied.—C. H. K.

THE EUROPEAN FRIT FLY AND ITS FORMS IN NORTH AMERICA[1]

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The wide distribution and common occurrence of small black flies of the Dipterous genus *Oscinella* (=*Oscinis* auctt., family Chloropidae), together with their damage to important cereal crops and grasses, have aroused considerable interest in the various species concerned. The adults are frequently bred from wheat, oats and a number of other grasses, or appear in experimental cages over such plants. In Europe, a large amount of research has been done and many papers published on all phases of the bionomics of the economically important frit fly, *Oscinella frit* (Linnaeus), and its varieties. In North America, however, this species and its relatives do not seem to have attained the same importance as pests of grains as in the Palaearctic region.

The close similarity of these rather minute forms inevitably resulted in a number of proposed names with considerable confusion in their application. From the earlier stage of recognition and description of many species, the group passed through a later period in which many names were placed as synonyms, or at most varieties, of one species generally known as the European frit fly, *Oscinella frit*. Becker (1912) and Aldrich (1920) so regarded the various names and they have been followed by other workers, including myself (Sabrosky, 1936). One result of the lumping was the subsequent naming of several related species, because the proper names for these concepts had long been sunk in synonymy under the frit fly.

During the past few years, in the course of study of a large quantity of material from many institutions and collectors, the writer has come to the conclusion that the synonymy expressed by Aldrich and Becker is too broad. Intensive study in the family Chloropidae has dictated that apparently slight differences (or "varieties" of many authors) may and often do represent valid and consistent characters for the separation of

[1]Journal Article No. 351 (n. s.) from the Michigan Agricultural Experiment Station.

species. Thus there are several apparently distinct specific concepts whose identity in the past has been hidden under the name of *frit* in the determinations of most writers.

Both the typical *Oscinella frit* and the form *nitidissima* Meigen (usually accepted as a variety of *frit*) occur in North America and appear to be distinct from *O. soror* Macquart and *O. carbonaria* Loew. The latter two may possibly be genetic forms of the same species, but they are so different that the writer believes they should be accorded separate recognition, certainly until breeding studies settle the question of relationship. The form *pusilla* Meigen, often recorded from North America, is barely distinguishable from the typical *frit* and is included therewith in this paper.

The four recognized concepts will run directly to the correct species of *Oscinella* (Sabrosky, 1936), the last two appearing under their synonyms, *ainsliei* and *salinaria*, which were known to me at that time only from the descriptions. The characteristics upon which separation is based have been summarized here as a key, rather than repeated as complete descriptions.

KEX TO THE FRIT FLY AND RELATIVES IN NORTH AMERICA

1. Vertical triangle large, nearly touching the eyes at the vertex and reaching the anterior margin of the front; front black; cheeks comparatively broad, approximately ⅔–¾ the height of the third antennal segment; anterior cross-vein usually enters the discal cell distinctly beyond the mid-point (variable) 2

   Triangle smaller, short, extending only two-thirds of the distance to the anterior margin of the front, usually appearing smoother and more highly polished than the above; anterior portion of the front frequently with a reddish tinge (chiefly in *O. soror*); cheeks linear to sublinear, distinctly less than half as high as the third antennal segment, and appearing definitely narrow compared with the above; anterior cross-vein at or slightly before the mid-point of the discal cell 3

2. Mesonotum polished, not pollinose ..... **O. frit** var. **nitidissima**

   Mesonotum dull, covered with fine dark gray pollen ..... **O. frit**

3. Mesonotum polished, not pollinose; anterior portion of the front usually with reddish tinge ..... **O. soror**

   Mesonotum and upper part of the pleura dull, finely and densely pollinose, **O. carbonaria**

Oscinella frit (L.)

Musca frit Linnaeus. 1758. Syst. Nat., ed. X, p. 598.
Oscinis frit of authors.
Oscinis nigra Tucker. 1908. Ent. News, XIX, p. 272.
Oscinella frit; Becker. 1912. Ann. Mus. Nat. Hung., X, p. 113.
Oscinella frit; Aldrich. 1920. Jour. Agric. Research, XVIII, pp. 451–474.

The typical form occurs rather widely in North America, especially in northern and western United States, and Canada. The variety *pusilla* Meigen, sometimes recorded, is a typical

frit with less extensive black color on the legs. *Oscinis nigra* had already been referred to typical *frit* by Dr. Aldrich (1920).

Distribution: Aldrich (1920) recorded it from nearly every state in the Union, but many of his records were undoubtedly based on *O. carbonaria* and *O. soror*. Many of the writer's earlier determinations of *O. frit*, and those of other authors, are not available for rechecking, which might considerably extend the indicated distribution of the other forms. Available records of typical *frit* are from Ark., Calif., Conn., Colo., D. C., Idaho, Ind., Iowa, Kans., Maine, Md., Mass., Mich., Minn., Mo., Mont., Nebr., N. H., N. J., N. Mex., N. Y., N. Dak., Ohio, Okla., Penn., R. I., S. Dak., Tex., Utah, Vt., Va., Wash., Wis., Wyo.; Alberta, Brit. Col., Manitoba, Ontario, Sask.

Oscinella frit var. **nitidissima** Meigen

Chlorops nitidissima Meigen. 1838. Syst. Beschr., VII, p. 388.
Oscinella nitidissima; Becker. 1912. Ann. Mus. Nat. Hung., X, p. 113.

This form was regarded as a variety of *O. frit* by Aldrich, with *O. variabilis* as synonym. It is similar to *O. frit*, differing especially in the polished, non-pollinose mesonotum. Duda (1933) used the name *atricilla* Zetterstedt for this variety on the ground that Meigen's species was "*incerta*." I have seen the type of *nitidissima* in the Meigen collection at Paris, and find that it is really the well known, polished variety of *frit*.

Distribution: Fewer records are available than for *O. frit*, but these few indicate a similar northern and western range. Ariz., Calif., Colo., D. C., Idaho, Iowa, Md., Mont., N. J., N. Mex., N. Y., Ore., S. Dak., Tenn., Utah, Vt., Wash.; Alberta, Ontario.

Oscinella soror (Macq.)

Chlorops soror Macquart. 1849. Dipt. Exot., Suppl. IV, p. 306.
Oscinis tibialis Fitch. 1856. Second N. Y. Report, p. 532. (Separate, p. 300.) New synonym.
Oscinis variabilis Loew. 1863. Berl. Ent. Ztschr., VII, p. 42. (Cent. III, No. 79.) New synonym.
Botanobia ainsliei Curran. 1927. Canad. Ent., LIX, p. 292. New synonym.

Types of all species except *soror* Macq. have been seen by the writer.[2] Macquart's brief description reads "d'un noir luisant," which would limit *soror* either to this form or to *nitidissima*, and the indication of a yellowish face favors the

[2]My thanks are due to Mr. Nathan Banks, of the Museum of Comparative Zoology, Harvard University, and to Doctor J. McDunnough, of the Canadian Department of Agriculture, for the loan of paratype material in their care, and for additional comparisons with holotypes.

use for the former. The use of *soror* likewise agrees with the usage of Coquillett (1903). *Variabilis* had previously been used by both Becker and Aldrich as a synonym of *nitidissima*.

Distribution: Apparently eastern, from the available records. Ark., D. C., Ga., Ill., Ind., Iowa, Kans., Md., Mich., Minn., Mo., N. J., N. Y., N. Dak., Ohio, Okla., Penn., S. C., S. Dak., Va., Wis.; Manitoba.

Oscinella carbonaria (Lw.)

Oscinis carbonaria Loew. 1869. Berl. Ent. Ztschr., XIII, p. 42. (Cent. VIII, No. 76.)
Oscinis obscura Coquillett. 1900. U. S. Nat. Mus. Proc., XXII, p. 266. New synonym (?).
Botanobia salinaria Curran. 1927. Canad. Ent., LIX, p. 292. New synonym.

The types of the first two species, and a female paratype of the last, have been studied by the writer. *Carbonaria* had previously (Becker, Aldrich) been regarded as a synonym of *O. frit* var. *pusilla* Meigen, but the latter seems to be merely a form of typical *Oscinella frit*. I therefore propose to resurrect the name *carbonaria* for the species.

Oscinis obscura, which had been placed as a variety of *O. coxendix* by Becker but had been referred to *O. frit* (*sens. lat.*) by the writer (Sabrosky, 1936, p. 723), appears to belong here. Although described from Porto Rico, and possibly a distinct species, I am unable to separate it from *carbonaria* at the present time. The specimen from Paradise Key, Florida (U. S. Nat. Mus. Colln.), recorded by Duda (1934, Konowia, XIII, p. 105) as *O. frit* var. *pusilla*, has been checked and is also a typical *carbonaria*.

Distribution: Apparently widely distributed over the eastern half from the available records. Ala., D. C., Fla., Ga., Ill., Iowa, Kans., La., Md., Mass., Mich., Minn., Miss., Mo., N. Y., Ohio, Okla., Penn., S. C., S. Dak., Tenn., Tex., Utah, Va., W. Va.; Nova Scotia.

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Coquillett, D. W. 1903. *In* Webster, F. M. Some insects attacking the stems of growing wheat, rye, barley and oats. U. S. Dept. Agric., Div. Ent., Bul. 42 (n. s.), 62 pp. (Chloropidae, pp. 40–62.)
Duda, O. 1933. Chloropidae. Lfg. 68 (*In* Lindner: Die Fliegen der Palaearktischen Region). (*O. frit* and varr., pp. 88–92.)
Sabrosky, C. W. 1936. A synopsis of the Nearctic species of Oscinella and Madiza based on a study of the types. Annals Ent. Soc. Amer., 29: 707–728.

THE ANTERIOR PERISTIGMATIC GLANDS IN TRYPETID LARVAE

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Various workers have made mention of a peculiar series of glands which occur in many dipterous larvae. These structures, usually referred to as the peristigmatic glands, are found closely associated with both the anterior and posterior spiracles. The structure of the posterior spiracles and their peristigmatic glands in *Rhagoletis pomonella* Walsh has been well described and figured by Butt (1937). The present study is offered as a description of these glands in their relation to the anterior spiracles.

Sections were made of larvae representing a good many families and species of Diptera. The majority of these were found to possess peristignatic glands, though in a few forms none appeared to be present. *Rhagoletis suavis* Lw., the walnut husk maggot, was chosen as a representative form and the description and figures here refer to that species.

TECHNIQUE

The larvae used in this study had, for the most part, been preserved in alcohol, though a few fresh specimens were fixed in Dietrich's fluid. Little difference in the final results was noted for these two groups. The material was dehydrated in Cellosolve and Butyl alcohol and embedded in rubber paraffin. Sections cut at 6 microns were stained with Mallory's connective tissue stain. Better effects were obtained with the use of acid fuchsin rather than basic fuchsin in the Mallory's I solution. After passing the sections through xylol, 100 per cent and 95 per cent alcohols, they were run directly into Mallory's I for two minutes, and Mallory's II for five minutes, rinsed in 95 per cent alcohol, destained for about five minutes in 100 per cent alcohol, transferred to xylol and mounted in balsam. This simplified technique was found the most satisfactory of any tried both for speed and good results.

THE ANTERIOR RESPIRATORY ORGANS

The anterior spiracles of dipterous larvae are ordinarily composed of a number of finger-like lobes or tubes which arise from the posterior part of the prothorax (fig. 1, SP). These processes are merely distal prolongations of the stigmatic chamber or atrium which is in turn connected directly with the main dorsal tracheal trunk (fig. 2). Each finger of the spiracle (fig. 3) has a perforated tip through which air passes in the process of respiration. From the inner ectodermal lining of the

finger arise many small spine-like processes, especially near the tip, and the whole inner wall has a granular or rugose appearance. In some other species studied the spiracular openings were distinctly and prominently toothed.

The stigmatic chamber (fig. 4, ST C) is partially filled with a mass of reticulated material. In some larval forms this is made up of bars and spines which create cell-like vacuoles scattered throughout the chamber. In the present species, however, a fairly even layer of granular substance extends inward from the wall. There are occasional denser areas reaching out into the chamber. This reticulated material consists of modified exocuticula. Its purpose in both the spiracular fingers and the stigmatic chamber is obviously to prevent the passage of any foreign substances that may enter the stigmatic openings. Such a filtering apparatus is also present in the posterior atrial chamber. However, the anterior filter seems less dense in most cases and less dirt is usually collected in it. This is doubtless due to the fact that anterior spiracular openings, larger in number in this species are smaller in size than the posterior slits, and consequently themselves offer more resistance to the entrance of undesirable particles.

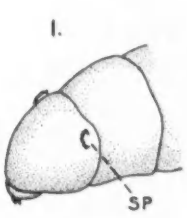
At the beginning of the second and third instars the spiracular structure is reformed and a new set of fingers or lobes is produced. This is illustrated in figure 4 where the second moult has not yet taken place but the cuticula and spiracular apparatus of the third instar have already been formed. Though they are not shown in this figure, the peristigmatic glands are present in the second instar. In the third stage larva the position of the preceding spiracles may be located by a scar formed in the cuticula. Figure 4 (SC E) indicates the point on the skin of the third stage larva at which the scar will be formed. A strand of cuticular tissue extending from the scar to the base of the stigmatic chamber may be traced in the third instar. This represents the course of the tube-like stigmatic chamber of the second instar. Sections cut across the base of the third stage stigmatic chamber (fig. 5, SC I) show the point of connection of the previous instar chamber.

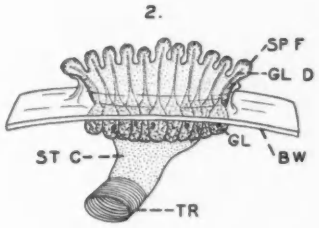
EXPLANATION OF PLATE

Fig. 1, General view of anterior end of larva. 2, Anterior respiratory organ with peristigmatic glands (diagrammatic). 3, Longitudinal vertical section of spiracular finger showing gland duct. 4, Section of spiracle cut in long axis of fingers showing stigmatic chambers of second and third instars. 5, Cross section of base of stigmatic chamber with internal scar of second instar chamber. 6, Longitudinal vertical section of spiracle, peristigmatic glands and part of stigmatic chamber.

ABBREVIATIONS

AD, air duct. BW, body wall. EN C, endocuticula. EX C, exocuticula. EX C2, exocuticula of the second instar. EX C3, exocuticula of the third instar. GL, peristigmatic gland. GL D, duct of peristigmatic gland. SC E, point at which external scar of previous instar chamber will be found. SC I, internal scar of previous instar chamber. SP, spiracle. SP 2, spiracle of second instar. SP 3, spiracle of third instar. SP F, spiracular finger. SP O, spiracular opening. ST C, stigmatic chamber. T, taenidia. TR, trachea.


1.
SP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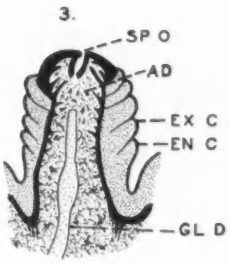
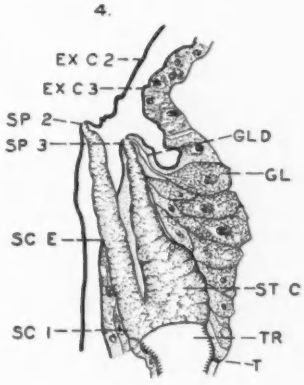
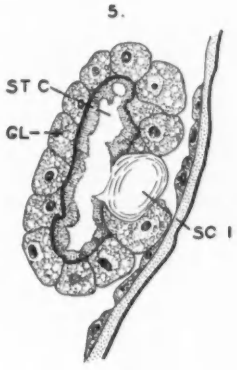
SP F
GL D
GL
BW
ST C
TR


3.
SP O
AD
EX C
EN C
GL D


4.
EX C 2
EX C 3
SP 2
SP 3
GL D
GL
SC E
ST C
SC I
TR
T


5.
ST C
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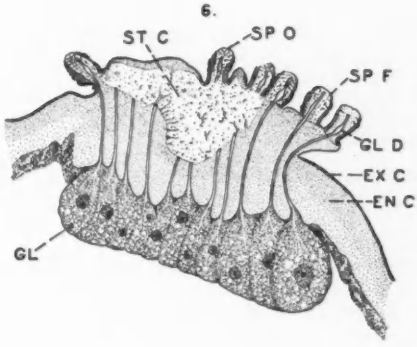
SC I


6.
ST C
SP O
SP F
GL D
EX C
EN C
GL

ANTERIOR PERISTIGMATIC GLANDS

The peristigmatic glands associated with the anterior spiracle are located in a crescent-shaped mass mostly around one side of the stigmatic chamber. It is very difficult to determine the actual number, but as a duct seems to lead from each gland cell to a finger of the spiracle, it must be assumed that, in general, their number corresponds to that of the fingers. This may not always be true, for where only three glands normally occur in the posterior spiracles, corresponding to the three spiracular slits, Bates (1934) reports the occurrence of a fourth gland in a single specimen of *Rhagoletis pomonella*. The number of anterior spiracular fingers varies even within the species and the number of gland cells would naturally vary in the same degree.

The peristigmatic glands are unicellular with a well developed nucleus. The duct which leads from each may be seen to have its origin well down within the gland, where it is at least sometimes branched (fig. 6). Dolley and Farris (1929) state that in the rat-tailed maggot *Eristalis tenax*, this internal duct, much convoluted, forms a tubule within the cell.

From the glands the ducts extend outward through the endocuticula until they reach the spiracular fingers, into which they pass. The ducts empty near the tips of these fingers.

The function of the peristigmatic glands is not definitely known. Wahl (1899) suggests that they may secrete a fatty substance which prevents the entrance of fluids into the spiracles. This seems the most logical explanation so far advanced. Many of the dipterous larvae which possess these glands live in a liquid or semi-liquid medium and their spiracles would conceivably be in need of such protection. This theory is further substantiated by the findings of Dolley and Farris (1929) who used Flemming's fluid for fixation. Their sections showed the characteristic reaction indicating the presence of fatty substances in the ducts.

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THE MOSQUITOES OF ARKANSAS by STANLEY J. CARPENTER. Mimeograph 8.5x10.75 inches, 89 pages, 31 figs., manilla cover. Published by ARKANSAS STATE BOARD OF HEALTH, Little Rock, Arkansas.

This is a bulletin prepared for workers and others interested in a general campaign to improve the malarial situation in Arkansas which has been one of the most backward of the states in malarial clean-up work.

The first fifteen pages deal with methods of collecting, preserving, counting, etc. Pages 69 to 82 have to do with control and survey methods. The bulk of the brochure deals with taxonomy, particularly of mosquito larvae. It covers forty-two species in nine genera of the Culicinae.—C. H. K.

MONOGRAPH OF A NEW NEOTROPICAL MUTILLID GENUS, PAPPOGNATHA

(Hymenoptera: Mutillidae)[1]

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The Mutillid species discussed herein have formerly been included in *Hoplomutilla* Ashmead, = *Tilluma* André, or have been included with a list of *species incertis sedis*. The generic name, *Pappognatha*, is proposed for these species because the mandibles in both sexes are entirely tomentose, except for their extreme tips. No other New World Mutillidae known to me have the mandibles clothed in this manner. Some of the species of females have formerly been assigned to *Hoplomutilla* Ashmead on account of their large quadrate heads, their diskiform first abdominal segment, and their bimaculate second abdominal segment, all of which give them a superficial resemblance to Ashmead's genus. During the course of a revisional study of *Hoplomutilla* it was noticed that the females here included all had tomentose mandibles and all had a pyriform thorax unlike that of *Hoplomutilla* females; this led to a search for other generic characters which resulted in the diagnosis which follows. Tentatively grouping these females as a new genus, the question immediately arose as to what the males might be like. Cresson (1902) described *Mutilla carmo*, a male from Santarem, Brazil. It has never been definitely assigned to any New World genus. The type of Cresson's species was examined and found to have tomentose mandibles, a diskiform first abdominal segment and other characters which leave no doubt that *carmo* Cresson represents the male sex of this genus.

The genus *Pappognatha* as known at the present time includes eleven species of females and two species of males. Five species of females and one species of male are described as new, and one new name is proposed. All types of previously described species have been examined in the course of the study. The geographical distribution of the genus ranges from Costa Rica to southern Brazil and Bolivia, specimens being recorded

[1]Paper No. 1635 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

from the following countries: Costa Rica, Panama, Colombia, British Guiana, French Guiana, Brazil, Ecuador, Peru and Bolivia.

Presumably the species of this genus are parasites of other wasps and bees as is the case with many other Mutillids, but nothing is definitely known regarding the identity of their hosts.

I am especially indebted to Dr. Hugo Kahl, Carnegie Museum, Pittsburgh, Pa., for the opportunity of examining the type of *carmo* Cresson. I wish also to express my appreciation and thanks to the following institutions and individuals for the loan of material and for their patience with me as it is slowly worked over and reported upon: British Museum (Natural History), London; Muséum Nationale d'Histoire Naturelle, Paris; Museo civico di storia naturale, Genoa, Italy; Zoologische Museum der Universität, Berlin; Zoological Museum, Hamburg, Germany; Deutsches Entomologisches Institut, Berlin-Dahlem; Zoologische Staats-Samlung, Munich; Oxford University, England; Mr. O. W. Richards, London, England; Professor Fabio Invrea, Genoa, Italy; Instituto Biologico, Sao Paulo, Brazil; Museo Paulista, Sao Paulo, Brazil; United States National Museum, Washington; Museum of Comparative Zoology, Cambridge, Mass.; Carnegie Museum, Pittsburgh, Pa.; and Cornell University, Ithaca, N. Y.

Genus **Pappognatha** n. gen.

Mutilla Auct. (in part). (New synonymy.)
Sphaerophthalma Cameron, Ann. Mag. Nat. Hist., Ser. 6, Vol. 19, p. 378, 1897, (in part). (New synonymy.)
Ephuta subgenus *Tilluma* André, Gen. Ins., fasc. 11, pp. 52–53, 1903 (in part). (New synonymy.)
Ephuta (*Ephuta*) André, Gen. Ins., fasc. 11, p. 62, 1903 (in part). (New synonymy.)
Hoplomutilla Mickel, Revista de Ent., Vol. 7, p. 178, 1937 (in part). (New synonymy.)

DIAGNOSIS

Female.—Head quadrate, very large, broader than the thorax; mandibles tomentose throughout, except the extreme tips, tridentate at the tip and with a blunt tooth within half way from the base to the tip. Posterior margin of genae distinctly carinate; eyes circular in outline, very prominent, hemispherical, without distinct facets; thorax pyriform, only slightly constricted at the propodeal spiracles; scutellar scale absent; lateral margins of mesonotum not toothed, with only a small tubercle; first abdominal segment diskiform, with distinct dorsal and anterior faces, the two usually separated by a transverse row of conspicuous spines, not sessile with the second segment; second tergite with a pair of yellow or ferruginous, integumental spots; last tergite

without a distinct pygidial area; posterior tibiae with three or less spines on the external surface; tibial spur at the tip of a long, slender, cylindrical or conical process; last tarsal segment with a lamellate process extending over and beyond the base of the claws; calcaria equal in length.

Male.—Head quadrate, very large, broader than the thorax; mandibles exceedingly broad, tomentose throughout, except the extreme tips; clypeus prominently produced into a broad nasutiform plate, convex above, concave below, the anterior margin very deeply emarginate medially; eyes circular in outline, very prominent, hemispherical, without distinct facets; ocelli very small; parapsidal furrows entirely absent; tegulae moderate in size, evenly convex; first abdominal segment diskiform, with distinct dorsal and anterior faces, a distinct ridge between the two; anterior face of first tergite with the lateral margins strongly produced medially to form a conspicuous tooth; stigma poorly developed; cell 2nd R_1+R_2 large, truncate at the tip; cells R+1st R_1 and R_5 distinct; cell R_4 present but less distinct than cell R_5; last tarsal segment with a lamellate process extending over and beyond the base of the claws; calcaria equal in length.

Genotype.—Mutilla pertyi Dalle Torre.

Most closely related to the genus *Hoplomutilla* Ashmead, by the shape of the eyes, large quadrate head, shape of first abdominal segment, maculation of second tergite of female, form of tibial spur of female, and form of last tarsal segment in both sexes; differs in the tomentose mandibles, pyriform thorax of female, number of spines on posterior tibiae of female, and diskiform first abdominal segment of male.

KEY TO THE FEMALES

1. Second abdominal tergite with a pair of postmedian, pale yellow, integumental spots 2
   Second abdominal tergite with a pair of median to premedian, ferruginous, integumental spots 5
2. Vertex clothed, or conspicuously maculated with pale pubescence; pale pubescence on tergites three to five not at all, or very narrowly, interrupted medially 3
   Vertex apparently, entirely black pubescent, but marked with an almost obsolete and obscure, V-shaped spot of pale pubescence, the arms of the V narrow and extending forward to the eyes; pale pubescence on tergites three to five broadly interrupted medially ..... **pertyi**
3. Tergites three to five clothed throughout with pale pubescence 4
   Tergites three to five very narrowly, but distinctly interrupted medially with black ..... **limes**
4. Head and second abdominal tergite clothed entirely with pale golden pubescence ..... **myrmiciformis**
   Front and vertex black pubescent, except a very broad U-shaped mark of pale golden pubescence on the vertex and front; second abdominal tergite black pubescent except the lateral margins and integumental spots ..... **rotifera**
5. Second tergite with strong, conspicuous, short, parallel, oblique carinae, the integumental spots finely, longitudinally striate between the carinae ..... **radiata**
   Second tergite with rudimentary and indistinct carinae, or without carinae; integumental spots glabrous 6

6. Integumental spots of second tergite comparatively small, separated by a space of about equal to their own transverse diameter..... **lauta**
   Integumental spots larger, separated by a space much less than their own transverse diameter..... 7
7. Integumental spots of second tergite elongate, ovate..... 8
   Integumental spots of second tergite circular..... 9
8. Anterior and dorsal faces of first tergite separated by a transverse row of conspicuous spines; pale pubescence of tergites three to five broadly interrupted medially..... **arenacea**
   Anterior and dorsal faces of first tergite separated by a slightly tuberculate, transverse ridge, but without spines; pale pubescence of tergites three to five very narrowly interrupted medially..... **patruelis**
9. Pronotum clothed with sparse, black pubescence; pale tomentose, oblique lines on vertex not extending anteriorly along the inner eye margins..... 10
   Pronotum entirely pale tomentose; pale tomentose, oblique lines on vertex extending anteriorly along inner margin of eyes and uniting with pale pubescence of genae in front of eyes..... **torquata**
10. Integumental spots moderate in size, separated by a space equal to two-thirds their transverse diameter, their outer margin clothed with pale tomentose pubescence..... **speciosa**
    Integumental spots large, separated by a space equal to one-third their transverse diameter, glabrous, not pubescent throughout, except for a few, scattered, erect hairs..... **egregria**

KEY TO THE MALES

1. Mesosternum with a distinct, slightly transverse tubercle in front of the middle coxae; antero-lateral areas of second abdominal tergite with a distinct spot of appressed, pale pubescence..... **carmo**
   Mesosternum with a distinct, oblique ridge in front of each middle coxae, the inner end of the carina almost reaching the margin of the coxal cavity; antero-lateral areas of second tergite with only sparse, erect, pale hairs..... **obliqua**

Pappognatha pertyi (Dalle Torre). (New combination).

1855. *Mutilla bucephalus* Smith, Cat. Hymen. Brit. Mus., Vol. 3, p. 53, female (nec Perty).
1897. *Mutilla pertyi* Dalle Torre, Cat. Hymen., Vol. 8, p. 72, female.
1903. *Ephuta* (*Tilluma?*) *bucephala* André, Gen. Ins., fasc. 11, p. 53, female.
1913. *Tilluma bucephala* André, Mission Amerique du Sud, Vol. 10, fasc. 1, p. 2, female (in part., Brazil record only).
1937. *Hoplomutilla pertyi* Mickel, Revista de Ent., Vol. 7, p. 178, female.

Type.—Female, Para, Brazil, in British Museum (Natural History), London. The type is labeled Para, Brazil, although the description only mentions Brazil.

Specimens examined.—Female, Para, Brazil (Baker) [Cornell Univ.]; female, Para, Brazil, September 6, 1901 (Ducke) [Mus. Nat. d'Hist. Nat., Paris].

May be easily recognized by the apparently black pubescent vertex, the pale pubescent markings on the vertex obscure; the small, pale yellow, slightly postmedian, integumental spots on the second tergite, the spots separated by a space slightly greater than their own diameter; and the broadly interrupted pale pubescence on tergites three to five. The following new species, *obliqua*, is probably the male of *pertyi*.

Pappognatha obliqua n. sp.

Male.—Black; head very large, quadrate, slightly broader than long; front and vertex with sparse, erect, pale pubescence, except a broad, transverse area through the ocelli with sparse, short, black pubescence; genae and head beneath pale tomentose in addition to sparse, erect, pale pubescence; mandibles extraordinarily broad throughout, pale tomentose throughout, and with sparse, erect, pale hairs; clypeus broadly nasutiform with a deep, rounded emargination medially, the depth of the latter three-eighths the length of the clypeus; antennal tubercles very widely separated, the distance between them equal to half the length of the scape; first segment of flagellum longer than the second, but shorter than the second and the third united; front with a median, longitudinal, impressed line not reaching the anterior ocellus; front and vertex with moderate, distinct punctures, the space between the latter usually equal to the diameter of the punctures; puncturation of genae obscured by the tomentose pubescence; postero-lateral angles of head rounded; thorax thinly tomentose and with sparse, erect, pale hairs, except the dorsum of propodeum densely tomentose, and the pronotum, mesonotum and scutellum as follows: anterior margin of pronotum, and posterior half of scutellum with sparse, erect, pale hairs, the remainder of pronotum, mesonotum and scutellum with short, sparse, black, erect hairs and short, recumbent, spatulate hairs; pronotum with moderately large, dense, somewhat confluent punctures; mesonotum with moderate, close, distinct punctures; scutellum strongly convex, slightly glabrous and impunctate on the median line, otherwise with dense, moderate punctures; dorsum of propodeum apparently reticulate, but obscured by the dense, tomentose pubescence; propleurae with only scattered, small punctures, a strong, sharp carina at the anterior margin; dorsal and ventral areas of mesopleurae strongly convex, separated by a deep groove, the elevated areas with moderate, distinct punctures, the anterior and posterior areas practically impunctate; metapleurae practically impunctate; anterior third of sides of propodeum impunctate, the posterior two-thirds deeply, confluently punctate; mesosternum with a distinct, oblique ridge in front of each middle coxae, the ridge extending inward and almost meeting the edge of the coxal cavity; tegulae glabrous, the anterior third, and outer and inner margins distinctly punctate and with recumbent, black hairs; abdomen with dense, pale, tomentose pubescence on dorsal face of first tergite, broad lateral margins and postero-lateral angles of second tergite, and lateral fifths of third and fourth tergites, and with thin, pale, tomentose pubescence on all the sternites; lateral areas of the second tergite with sparse, erect, pale hairs, the remainder of the second and following tergites with black pubescence, that on the disk of the second very sparse; anterior face of first tergite glabrous, practically impunctate, the lateral margins strongly produced medially to form a conspicuous tooth; dorsal face of first tergite apparently punctate, but obscured by the dense, tomentose pubescence; second tergite with moderate, distinct punctures laterally, somewhat indistinct and smaller posteriorly, the anterior half of the disk glabrous and with the punctures scattered; tergites three to six with fine and small punctures intermixed;

second sternite strongly gibbose anteriorly at the middle, with sparse, small punctures; proximal fourth of wings hyaline, the distal three-fourths fuliginous; stigma very small; cell 2nd R_1+R_2 broad, truncate at the tip; cell R_5 receiving vein M_3+_4 one-third the distance from the base to apex; cell R_4 present but indistinct; legs pale tomentose and with sparse, erect, pale hairs; tibial spine short and at the apex of a short, conical process; tibiae not spined externally; calcaria pale, equal in length; last tarsal segment produced into a short, lamellate plate covering the bases of the claws, the process not emarginate. Length, 12 mm.

Holotype.—Male, Para, Brazil, October 19, 1901 (Ducke), in Muséum Nationale d'Histoire Naturelle, Paris.

Paratype.—Male, Para, Brazil, October 19, 1901 (Ducke), in University of Minnesota collection.

Closely related to *carmo* Cresson; differs in having a pair of oblique ridges on the mesosternum, one in front of each middle coxae, instead of a distinct tubercle as in *carmo*, in having only erect, pale hairs clothing the antero-lateral areas of the second tergite, and in having scattered punctures on the anterior middle half of the second tergite instead of practically impunctate as in *carmo*. This is probably the male of *pertyi* (Dalle Torre).

Pappognatha limes n. sp.

1913. *Tilluma bucephala* André, Mission Amerique du Sud, Vol. 10, fasc. 1, p. 2, female (in part., Ecuador and Peru records). (New synonymy.)

Female.—Black, the second abdominal tergite maculated with a pair of yellow, integumental spots; front and vertex sparsely, black pubescent, except the vertex with a broad, thickly pale tomentose, oblique stripe behind each eye, the two stripes confluent on the midline of the vertex posteriorly; remainder of head thinly pale tomentose and with scattered, erect, pale hairs; antennal scrobes strongly carinate above; front and vertex anterior to the pale tomentose stripes densely, distinctly punctate, the vertex elsewhere and the genae with distinct, separated punctures; front with a median, longitudinal, impressed line extending from between the antennal tubercles to a point in line with the middle of the eyes; posterior margin of genae defined by a distinct, slightly crenulate carina; dorsum of thorax sparsely black pubescent with scattered, erect hairs and recumbent, short, spatulate hairs, except the anterior margin of pronotum pale tomentose, the mesonotum with a broad, transverse band of thick, pale, tomentose pubescence, broadly interrupted medially with black, thus forming a pair of large, transverse, pale tomentose, postero-lateral spots, each obscurely connected with a lateral, tomentose stripe on the propodeum; lateral, pale tomentose stripes on propodeum moderately broad and confluent on the posterior half, thus forming a median, wedge-shaped, black pubescent area on the propodeum anteriorly; pleural areas entirely tomentose, the propleurae

thinly so; pronotum, mesonotum and wedge-shaped, black pubescent area of propodeum with moderate, distinct, close punctures; propleurae with moderate, separated punctures; puncturation of mesopleurae and metapleurae obscured by the thick, tomentose pubescence; sides of propodeum with moderate, separated punctures; anterior and dorsal faces of first tergite separated by a ridge bearing a row of prominent spines; first tergite thickly pale tomentose, except the anterior face with a median, triangular area posteriorly, black tomentose, the base of the triangle extending slightly onto the dorsal face, thus forming a broad, shallow, anterior emargination of the pale tomentose pubescence; second tergite with a pair of moderate, slightly postmedian, yellow, integumental spots, the latter slightly, transversely elliptical, the space between them equal to two-thirds their transverse diameter; second tergite thickly black tomentose and with scattered, erect, black hairs, except the integumental spots thinly pale tomentose and with scattered, erect, yellow hairs, and the lateral margins of the tergite broadly, pale tomentose; tergites three to five pale tomentose, interrupted medially by a very narrow black line (thus the name *limes*, a narrow path separating two fields); all the sternites thinly pale tomentose; legs black, thinly pale tomentose and with sparse, erect, pale hairs, except the femora above distally and the tibae externally with a few erect, black hairs; tibiae externally with a series of three, short spines, each at the tip of a short, conical process; tibial spur at the tip of a long, conical process; lamellate process of last tarsal segment not emarginate medially; calcaria pale, equal in length. Length, 11.5 mm.

Holotype.—Female, Pozuzu, Peru, 800 meters, in Muséum Nationale d'Histoire Naturelle, Paris.

Paratypes.—Two females, Pozuzu, Peru [Mus. civ. stor. nat., Genoa, Italy; and Univ. of Minnesota]; female, Guayaqil, Ecuador, November, 1902 (Buchwald) [Mus. Nat. d'Hist. Nat., Paris].

Resembles *pertyi*, but the integumental spots on the second tergite are larger, the tomentose maculation of the vertex is much denser, the tomentose maculation of the dorsum of thorax is denser and more conspicuous, the pale tomentose bands on tergites three to five are very narrowly interrupted instead of very broadly interrupted as in *pertyi*, and the pale tomentose band on the dorsal face of the first tergite is only shallowly, broadly emarginate at the middle anteriorly, instead of broadly interrupted as in *pertyi*.

Pappognatha rotifera (Gerstaecker). (New combination.)

1874. *Mutilla rotifera* Gerstaecker, Arch f. Naturg., Vol. 40, p. 56, female.
1897. *Mutilla rotifera* Dalle Torre, Cat. Hymen., Vol. 8, p. 78, female.
1903. *Ephuta* (*Tilluma*) *rotifera* André, Gen. Ins., fasc. 11, p. 53, female.

Type.—Female, No. 19289, Bogota, Colombia (Lindig), in Zoologische Museum der Universität, Berlin.

Specimens examined.—Female, Muzo, Colombia (Prof. Fabio Invrea, Genoa, Italy).

This species possesses a very broad, strongly arcuate, pale golden, tomentose band on the vertex, extending anteriorly along the inner margins of the eyes where it unites with the pale tomentose, anterior margin of the front, thus forming a heavy, U-shaped, pale golden tomentose mark on the vertex and front. The pale tomentose tergites three to five are not at all interrupted medially. The yellow integumental spots of tergite two are large, separated by only about one-third the transverse diameter of the spots, the latter slightly postmedian and thinly, pale yellow tomentose.

Pappognatha myrmiciformis (Cameron). (New combination.)

1897. *Sphaerophthalma myrmiciformis* Cameron, Ann. Mag. Nat. Hist., series 6, Vol. 19, p. 378, female.
1903. *Ephuta* (*Ephuta*) *myrmiciformis* André, Gen. Ins., fasc. 11, p. 62, female.

Type.—Female, Bugaba, Panama (Champion, in British Museum (Natural History), London.

Specimens examined.—Two females, Zent, Costa Rica, March, 1924 (Wm. Mann) [United States National Museum; and Univ. of Minn.]; female, Las Mercedes, bei San Jose, Costa Rica, October 22, 1926 (F. Nevermann) on blossoms of Tuga [Zool. Mus., Hamburg, Germany]; female, Irazu, Costa Rica (H. Rogers) [Brit. Mus. (Nat. Hist.)].

Differs from other species in the genus in being entirely pale golden tomentose, except a transverse, narrow line on the mesonotum anteriorly, and a narrow, longitudinal, median, black line on the mesonotum and propodeum. The yellow, integumental spots of second tergite are slightly postmedian and almost obscured by the pale golden, tomentose pubescence. This species greatly resembles the ant, *Camponotus sericeiventris*, according to Cameron.

Pappognatha carmo (Cresson). (New Combination.)

1902. *Mutilla carmo* Cresson, Trans. Amer. Ent. Soc., Vol. 28, p. 70, male.
1903. —— *carmo* André, Gen. Ins., fasc. 11, p. 72, male.

Type.—Male, Santarem, Brazil, in Carnegie Museum, Pittsburgh, Pa.

The type of this species has been examined and compared with specimens from Para, Brazil, which have already been described on a preceding page as *obliqua*. This type and the two specimens of *obliqua* are the only male specimens of this genus known in collections.

The following descriptive characters are supplemental to Cresson's original description: Lateral margins of first abdominal tergite conspicuously, obtusely dentate at the middle; antero-lateral areas of second

tergite with a small spot of appressed, pale pubescence; pale pubescence on lateral areas of tergite five obscure, inconspicuous; mesosternum with a distinct, slightly transverse tubercle in front of each middle coxae.

Pappognatha lauta n. sp.

1902. *Mutilla Pertyi* Cresson, Trans. Amer. Ent. Soc., Vol. 38, p. 36, female (nec Dalle Torre). (New synonymy.)

Female.—Black, the second abdominal tergite maculated with a pair of ferruginous, integumental spots; head clothed with sparse, erect, black hairs and very short, recumbent, black pubescence, except the vertex with a broad, oblique, pale tomentose line behind each eye, the two lines confluent posteriorly, and the mandibles, clypeus, scape and genae thinly pale tomentose, and with sparse, erect, pale hairs; first segment of flagellum equal to the length of flagellar segments two and three united; antennal scrobes sharply carinate above; front with a median, longitudinal, impressed line extending from between the antennal tubercles to a point in line with the middle of the eyes; front and vertex with moderate, dense punctures, the latter becoming separated on the posterior part of vertex; genae with moderate, distinct, separated punctures, and the posterior margin defined by a sharp carina; dorsum of thorax with sparse, erect, black hairs and very short, black, recumbent pubescence, except the mesonotum with a pair of pale tomentose spots at the postero-lateral angles, the spots confluent with a pair of lateral, pale tomentose lines on the propodeum; pleural areas entirely, thinly, pale tomentose and with sparse, erect, pale hairs; humeral angles slightly dentate; pronotum and mesonotum with moderate, dense, distinct punctures; propleurae with moderate, close, distinct punctures, the anterior margin defined by a carina; mesopleurae impunctate anteriorly, with moderate, distinct, close punctures posteriorly; metapleurae impunctate; sides of propodeum with moderate, distinct, slightly separated punctures; abdomen with sparse, erect, black hairs and short, black pubescence, except the ferruginous, integumental spots with only the erect, black hairs, and the dorsal face of first tergite broadly interrupted medially with black, lateral margins of second tergite entirely, tergites three to six broadly interrupted medially with black, and the sternites entirely, all pale tomentose, densely so on the tergites, thinly on the sternites; anterior and dorsal faces of first tergite separated by a ridge bearing a transverse row of strong spines; second tergite simple, without longitudinal carinae, finely punctate throughout, except the erect hairs arising from moderate, distinct punctures; ferruginous, integumental spots of second tergite circular, slightly premedian, separated by a space equal to six-sevenths of their transverse diameter; posterior portion of pygidial tergite glabrous, impunctate; legs black, thinly pale tomentose, and with sparse, erect, pale hairs, except the tibiae externally with scattered, erect, black hairs; posterior tibiae with a series of three spines externally, the spines at the tip of cylindrical processes equal in length to the spines; tibial spur at the end of a long, cylindrical process twice the length of the spine; lamellate process of last tarsal segment not emarginate; calcaria pale, equal in length. Length, 9 mm.

Holotype.—Female, Santarem, Brazil, May, 1919 (S. M. Klages), in Carnegie Museum, Pittsburgh, Pa.

Paratypes.—Female, Santarem, Brazil, May, 1919 (S. M. Klages); two females, Santarem, Brazil, June, 1919 (S. M. Klages); female, Santarem, Brazil, February; female, Santarem, Brazil, November; in Carnegie Museum, Pittsburgh, Pa., American Entomological Society, Philadelphia, Pa., and University of Minnesota.

Resembles *arenacea*, but the integumental spots of second tergite are smaller, circular and more widely separated, and the vertex is maculated with oblique, tomentose lines, confluent posteriorly. This is probably the female of *carmo* (Cresson). Cresson's material from Santarem, Brazil, determined as *pertyi* has been examined and found to be the same as this species.

Pappognatha arenacea n. nom.

1855. *Mutilla sabulosa* Smith, Cat. Hymen. Brit. Mus., Vol. 3, p. 49, female. (nec Klug).
1897. *Mutilla sabulosa* Dalle Torre, Cat. Hymen., Vol. 8, p. 83, 85, female.
1903. —— *sabulosa* André, Gen. Ins., fasc. 11, p. 74, female.

Type.—Female, Rio; Amazons, Brazil (H. W. Bates), in Saunders' collection, Oxford University, England.

The name *sabulosa* is preoccupied in the genus *Mutilla* by *sabulosa* Klug, 1835, so the above name is proposed to replace it. The type has been examined and the following descriptive notes are supplementary to Smith's description:

Front and vertex black pubescent, some of the black pubescence spatulate; antennal scrobes strongly carinate above; posterior margin of genae defined by a distinct carina; dorsum of thorax clothed with sparse, erect, black pubescence and thick, recumbent, black, spatulate pubescence, except the mesonotum with a pair of pale tomentose, postero-lateral spots, the latter indistinctly connected with a pair of pale tomentose, lateral stripes on the propodeum; humeral angles distinctly angulate; second tergite with a pair of large, ovate, slightly premedian, dark ferruginous, integumental spots; lateral thirds of dorsal face of first abdominal tergite densely pale tomentose, the dorsal and anterior faces separated by a conspicuous row of spines; second tergite with rudimentary, obscure, short, parallel, interrupted, longitudinal carinae, the latter not at all evident on the ferruginous spots; tergites three to five pale tomentose, but each broadly interrupted medially with black; legs pale tomentose and with scattered, erect, pale hairs, except the dorsal area of the femora distally and the tibiae externally with sparse, erect, black hairs; tibial spur at the end of a long, cylindrical process; calcaria pale.

Only the unique type has been seen.

Pappognatha radiata (André). (New combination.)

1906. *Ephuta* (*Tilluma*) *radiata* André, Zeit. Hymen. Dipt., Vol. 6, p. 35, female.

Type.—Female, French Guiana (Cayenne), in Muséum Nationale d'Histoire Naturelle, Paris.

Specimens examined.—Female, Pied Saut, Oyapok River, French Guiana (S. M. Klages) [Carnegie Mus., Pittsburgh, Pa.]; female, Paraicabo, French Guiana, September [Mus. Nat. d'Hist. Nat., Paris]; female, French Guiana [Mus. Nat. d'Hist. Nat., Paris]; three females, Moraballi Creek, Essequibo River, British Guiana, September 18, 1929, October 2, 1929, and November 6, 1929 (O. W. Richards) [O. W. Richards, London, and Univ. of Minnesota]; female, Source of Essequibo River, British Guiana (J. Ogilvie) [Mus. Comp. Zool., Cambridge, Mass.].

Differs from other species in the genus by the conspicuous, interrupted carinae on the second tergite and the very large, ferruginous, integumental spots, the latter with the spaces between the carinae striate.

Pappognatha patruelis (André). (New combination.)

1898. *Mutilla* (*Ephuta*) *patruelis* André, Ann. Soc. Ent. France, Vol. 67, p. 44, female.

1903. *Ephuta* (*Ephuta*) *patruelis* André, Gen. Ins., fasc. 11, p. 62, female.

Type.—Female, Bahia, Brazil, in Muséum Nationale d'Histoire Naturelle, Paris.

Paratype.—Female, Terra Nova, Prov. Bahia, Brazil, (Gounelle, 1888), in Muséum Nationale d'Histoire Naturelle, Paris.

Specimens examined.—Female, Laranja da Terra, Affonso Claudio, Espirito Santo, Brazil, September 20, 1928 (O. Conde) [Univ. of Minnesota]; female, Sao Bernardo, Sao Paulo, Brazil, January 28 [Instituto Biologico, Sao Paulo, Brazil]; two females, Ilha de S. Sebastiao, Sao Paulo, Brazil, 1906 (Fr. Guenther) [Museo Paulista, Sao Paulo, Brazil, and Univ. of Minnesota]; female, Brazil [Saunders' collection, Oxford Univ., England]; female, without data [Deutches Entomologisches Institut, Berlin-Dahlem].

Differs distinctly from other species in lacking the conspicuous spines at the junction of the anterior and dorsal faces of the first abdominal tergite; the entirely black pubescent head and the very large, ferruginous, integumental spots on the second tergite are good diagnostic characters.

Pappognatha torquata n. sp.

Female.—Black, the second abdominal tergite maculated with a pair of moderately large, circular, ferruginous, integumental spots; head clothed with sparse, erect, black hairs and short, recumbent, black pubescence, except the genae pale tomentose and the vertex with a pair of broad, oblique, pale tomentose lines uniting on the median line posteriorly to form a short, longitudinal line, and continuing anteriorly along the inner margin of the eyes to unite below the eyes with the pale tomentose pubescence of the genae; mandibles, clypeus and scape thinly pale tomentose and with sparse, erect, pale hairs; antennal tubercles widely separated; first segment of flagellum equal in length to segments two and three united; antennal scrobes sharply carinate above; front with moderate, distinct, dense punctures; front with a shallow, median, longitudinal, impressed line extending from between the antennal tubercles to a point in line with the middle of the eyes; vertex and genae with distinct, moderate, separated punctures; posterior margin of genae defined by a sharp carina; dorsum of thorax clothed with scattered, erect, black hairs, and sparse, short, recumbent, black pubescence, except the pronotum entirely pale tomentose, the posterior half of mesonotum with a transverse, broad, pale tomentose band broadly interrupted medially and the propodeum with a pair of lateral, pale tomentose stripes connecting anteriorly with the transverse band on the mesonotum; pleural areas entirely pale tomentose and with scattered, erect, pale hairs; humeral angles angulate but not prominent; pronotum and mesonotum with moderate, dense, distinct punctures; dorsum of propodeum with large, dense, distinct punctures; propleurae with moderate, distinct, separated punctures; mesopleurae impunctate, except a few, obscure punctures at the posterior margin; metapleurae impunctate; sides of propodeum with moderately large, distinct separated punctures; first tergite entirely pale tomentose, except a black tomentose spot on the anterior face at its median, posterior margin and extending slightly on to the dorsal face; anterior and dorsal faces of first tergite separated by a transverse ridge bearing a row of conspicuous spines, each of the latter bearing a long, black hair; second tergite black tomentose and with scattered, erect, black hairs, except the circular, ferruginous spots not at all tomentose, with only scattered, erect, ferruginous hairs, and the broad, lateral margins of the tergite pale tomentose; ferruginous, integumental spots moderately large, separated by a space equal to two-fifths of their transverse diameter, median in position between the anterior and posterior margins; tergites three to five and the pygidial tergite, entirely pale tomentose and with scattered, erect, pale and black hairs, except the pale tomentose pubescence very narrowly interrupted medially with black on each tergite, forming a narrow, black, median, longitudinal line; posterior part of pygidial tergite beyond the pubescence, glabrous; all the sternites entirely pale tomentose, more thickly so at the posterior margin of each tergite; second sternite with scattered, moderate punctures, the latter becoming closer at the posterior margin; legs black, thinly pale tomentose and with sparse, erect, pale hairs; posterior tibiae with only a single external spine about one-third the distance from the base to the tip; external

tibial spur at the tip of a slender, conical process, the spine at the tip one-half the length of the process; lamellate process of last tarsal segment not emarginate; calcaria pale, equal in length. Length, 14 mm.

Holotype.—Female, Bolivia, in Muséum Nationale d'Histoire Naturelle, Paris.

Easily recognized by the large, ferruginous, circular, integumental spots of the second tergite, the pale tomentose pronotum, and the absence of carinae on the second abdominal tergite.

Pappognatha speciosa n. sp.

Female.—Black, the second abdominal tergite maculated with a pair of moderately large, ferruginous, circular, integumental spots, the outer margin of the latter pale tomentose; head clothed with sparse, erect, black hairs and short, recumbent, black pubescence, except the genae pale tomentose and the vertex with a pair of broad, oblique, pale tomentose lines uniting on the midline posteriorly, but not extending anteriorly along the inner eye margins; mandibles, clypeus and scape thinly pale tomentose and with sparse, erect, pale hairs; antennal tubercles widely separated; first segment of flagellum slightly longer than the combined length of the second and third; antennal scrobes sharply carinate above; median, impressed, longitudinal line on front anteriorly very shallow, obscure; front with moderate, dense, distinct punctures, the vertex and genae with moderate, close but not dense, distinct punctures; posterior margin of genae defined by a sharp carina; dorsum of thorax clothed with sparse, erect, black hairs, and short, recumbent, black pubescence, except the anterior margin of pronotum with a row of sparse, erect, pale hairs, the posterior half of mesonotum with a broad, pale tomentose band broadly interrupted medially, and the propodeum with a pair of lateral, pale tomentose stripes uniting anteriorly with the transverse band on mesonotum and connected posteriorly by pale tomentose pubescence on propodeum; humeral angles angulate but not prominent; pronotum, mesonotum and dorsum of propodeum with moderate, dense, distinct punctures; posterior face of propodeum indistinctly punctate; propleurae with moderate, close, deep punctures; mesopleurae impunctate anteriorly, with separated, obscure punctures posteriorly; metapleurae impunctate; sides of propodeum with moderate, close, distinct punctures; pleural areas entirely pale tomentose, the mesopleurae and metapleurae more thickly so than the propleurae and sides of propodeum; first tergite pale tomentose, except a large, median, posterior, triangular, black tomentose spot on the anterior face and a smaller, similar spot on the dorsal face, the bases of the two triangular spots confluent at the spinose ridge separating the two faces; ferruginous, integumental spots of second tergite moderate in size, median in position between anterior and posterior margins, with scattered, erect, ferruginous hairs, a very rudimentary, obscure carina or cariniform tubercle at the base of each hair and each spot with its outer margin pale tomentose; space between the integumental spots equal to two-thirds the transverse diameter of the spots; second

tergite otherwise black tomentose and with scattered, erect, black hairs, except the broad, lateral margins pale tomentose; tergites three to five and pygidial tergite pale tomentose and with scattered, erect, pale hairs, except each tergite with the pale tomentose pubescence narrowly interrupted medially with black, forming a narrow, median, longitudinal, black line on these tergites; pygidial tergite glabrous posterior to the tomentose area; second sternite with moderate, scattered punctures, the latter becoming closer towards the posterior margin; all the sternites pale tomentose, more thickly so at the posterior margin of each; legs black, thinly pale tomentose throughout and with sparse, erect, pale hairs; hind tibiae with three spines externally in addition to the external tibial spur; lamellate process of last tarsal segment not emarginate; calcaria pale, equal in length. Length, 14 mm.

Holotype.—Female, Yurimaguas, Peru, in Muséum National d'Histoire Naturelle, Paris.

Resembles the following species but differs in having the integumental spots of the second tergite smaller, and the outer margin of the spots pale tomentose.

Pappognatha egregia n. sp.

Female.—Black, the second abdominal tergite maculated with a pair of large, circular, ferruginous, integumental spots; head clothed with sparse, erect, black hairs, and short, recumbent, black pubescence, except the genae pale tomentose and the vertex with a pair of broad, oblique, pale tomentose lines confluent on the median line posteriorly, not extending anteriorly along the inner eye margins; mandibles, clypeus and scape thinly pale tomentose and with sparse, erect, pale hairs; antennal tubercles widely separated; first segment of flagellum slightly longer than the combined length of the second and third segments; antennal scrobes sharply and conspicuously carinate above; front with moderate, dense, distinct punctures; vertex and genae with moderate, close, distinct punctures; posterior margin of genae defined by a distinct carina; dorsum of thorax clothed with scattered, erect, black hairs and short, recumbent, black pubescence, except the mesonotum with a broad, pale tomentose, transverse band on the posterior half broadly interrupted medially, and the propodeum with a pair of lateral, longitudinal, pale tomentose stripes, obscurely connected anteriorly with the transverse band on the mesonotum; pronotum, mesonotum and dorsum of propodeum with moderate, dense, distinct punctures; posterior face of propodeum indistinctly punctate and pale tomentose, thus uniting the lateral stripes posteriorly; humeral angles distinctly angulate but not prominent; pleural areas entirely pale tomentose; propleurae with moderate, very close, distinct punctures; anterior half of mesopleurae impunctate, the posterior half with moderate, close punctures obscured by the pale pubescence; metapleurae impunctate; sides of propodeum with moderate, close, distinct punctures; first tergite entirely pale tomentose, except a very obscure, dark tomentose spot on the anterior face at the posterior median margin and extending slightly onto the dorsal face; anterior and dorsal faces of first

tergite distinctly separated by a transverse, spinose ridge, each spine bearing a long hair at its base posteriorly; second tergite with scattered, erect, black hairs and black, tomentose pubescence, except the broad, lateral margins pale tomentose, and the integumental spots with scattered, erect, ferruginous hairs; surface of second tergite with scattered, rudimentary, short, longitudinal carinae, the latter so poorly developed as to appear as tubercles, often at the base of an erect hair, the tubercles present on the integumental spots as well as elsewhere; integumental spots of second tergite large, the space between them equal to one-third their transverse diameter, median in position between the anterior and posterior margins; tergites three to five and the last tergite entirely pale tomentose, except each distinctly interrupted medially with black, forming a distinct, median, longitudinal, black line; posterior portion of pygidial tergite glabrous; all the sternites pale tomentose, more thickly so at their posterior margins; second sternite with scattered, small punctures, the latter becoming closer and larger at the posterior margin; legs black, thinly pale tomentose and with sparse, erect, pale hairs; hind tibiae with a series of three spines externally in addition to the terminal spur; lamellate process of last tarsal segment not emarginate; calcaria pale, equal in length. Length, 14 mm.

Holotype.—Female, Ega (Teffé), Amazonas, Brazil, in British Museum (Natural History), London.

Paratypes.—Two females, Amazonas, Brazil (Bates), in Zoologische Staats-Samlung, Munich, Germany, and University of Minnesota collection.

Closely related to *speciosa*, but differs in the larger, integumental spots of the second tergite which are bare throughout, except for the erect hairs, and thus without any tomentose pubescence at the outer margins.

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THE FEMALE OF AESHNA BILIOSA

(Odonata: Aeshnidae)

CLARENCE HAMILTON KENNEDY,
Ohio State University,
Columbus, Ohio

In a recent issue of this journal (Vol. XXXI (4): 573–577, figs. 1–7, 1938) I described the male of the new species, *Aeshna biliosa* Kennedy, from Ecuador and Peru. In April, 1939, I received from Mr. William Clarke-Macintyre, Esq., of Baños, the first female of this species. There is no doubt that this specimen is the female of *biliosa* because it was collected near Baños, Prov. Tungurahua, at an elevation of 2,000 meters, which is the general locality and elevation at which the male holotype was taken: because of the size of the female and the clear lemon-yellow face, black T-spot and general color pattern.

The drawings are by Begagy Benton, artist, (W.P.A. Project, Zoology and Entomology Department, Ohio State University), except for lettering and final corrections by the author. The description follows:

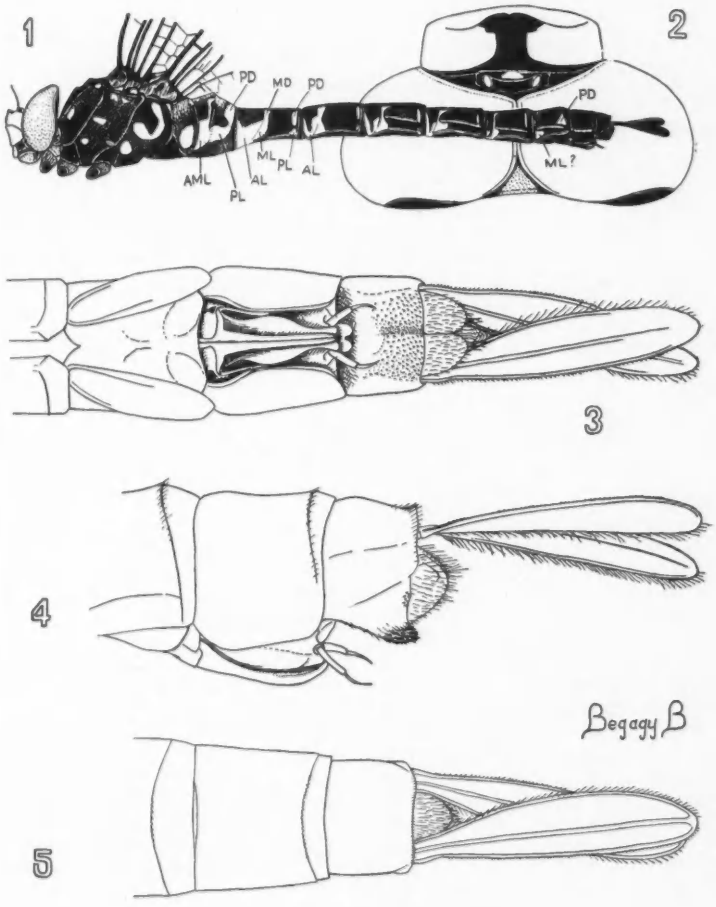
Aeshna biliosa Kennedy, female, allotype

(Figs. 1–7)

Length of abdomen 64 mm., including appendages which are 8 mm.; hind wing 55 mm. long and 17 mm. wide before level of nodus. Stigmas, fore wing 3.5 mm., hind wing 3.5 mm. long.

Head with labium chestnut brown; mandibles with side of extreme base black, mottled with brown on outer curve; labrum orange, a brown line on its lower edge, its upper edge with three black specks in three depressions connected by a narrow black line. *Sides*, *front* and *top* surface of the clypeus-frons area a clear lemon yellow except a black dorsal T-spot whose broad stem is almost as wide as the distance between the paired ocelli (fig. 2), and the down-turned posterior edge of the dorsal surface of the frons which is black as is the vertex and its surrounding sulcus. The delicate hairs on the clypeus, frons, vertex and occipital triangle are black. Occipital triangle narrowly black along lateral edges, which color shades into dusky yellow in its center. Ocelli with orange-brown reflections. Antennae black. Compound eyes brownish gray (papered specimen) with narrow yellow posterior edges. Rear of head jet black. (See fig. 2.)

Prothorax mottled in shades of dark brown (almost black) above, mottled faun and pale reddish brown on side. Edge of posterior lobe with a crest of erect pale brownish hairs which are one-third as long as



Aeshna biliosa Kennedy, *allotype female.*

Fig. 1. Color pattern of body. 2. Color pattern of top of head. 3. Ventral view of abdominal segments 8–10. 4. Lateral view of abdominal segments 9–10. 5. Dorsal view of abdominal segments 9–10.

the fore femur. The brown coxae clothed with dark brown and black hairs.

Pterothorax (fig. 1) of a dark brown ground color shading into black on edge of middorsal keel and on the lower edges of the mes- and metepimera; clothed with long black hairs. The following blue and yellow spots occur: (In the single allotype specimen the colors were badly injured by dipping the thorax into hot water to relax the wings for figs. 6 and 7), mesepisternum with a minute speck of blue at middle of base of lateral keel of the antealar sinus; a second blue spot twice as large on each side of upper end of middorsal keel where it crosses the antealar sinus (not visible in fig. 1); a paler spot of same size at base of costa, and a minute oval blue spot on lower end of mesepisternum. Mesepimeron with four pale spots, one of them above the lateral alar carina, one just below the carina, one on middle of sclerite and one on its lower convex end, the latter yellowish. Metepisternum with a blue spot above and another just below lateral alar carina. Metepimeron with a distinct blue spot above the alar carina and a U-shaped blue spot, with its U-opening forward, which covers the upper half of the sclerite; below the U-spot a rounded blue spot.

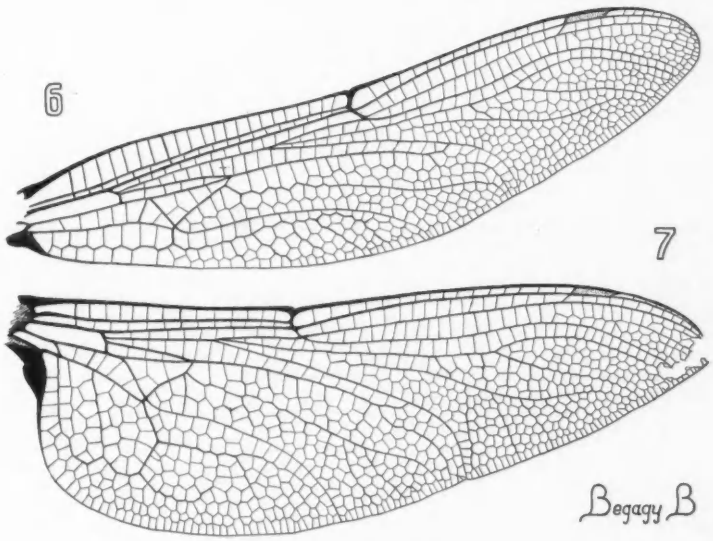
Legs with trochanter and basal two-thirds of femur reddish brown, apex of femur, tibia and tarsus black. Wings with veins black; stigmas reddish brown above, lemon yellow below; anal membrane of fore wing dark brown, of hind wing (fig. 7) sooty black with pale upper edge.

Abdomen with ground color of the sides and dorsum of segments 1, 2 and basal half of 3 dark brown; ground color of sides and dorsum of the remainder black. Sides below lower lateral keel of segments 1-7 dark brown; sterna dark brown. Segments 8-10 and appendages dark brown to black.

Abdominal spots (described in Walker's terms, 1912, p. 9): see our fig. 1 for pattern. Seg. 1 with spot D blue and small; spot L oval and occupying much of lower half of side of seg. 1. Seg. 2 with MD triangular above, its lower anterior angle drawn out into a broad line merged downward into the dorsal point of AML: the latter broadly fused into PL, which is narrowly connected with a fully developed PD: MD, AML and PL yellow, PD blue. Seg. 3 with AL triangular, its dorsal angles acute upwards, its posterior side confluent with ML, which is broadly connected above with MD: PD and PL narrow, slightly separated. PD and PL blue, the other spots yellow. Segs. 4, 5 and 6 subequal to each other in pattern which is as follows: AL a deeply cut V; ML and MD broadly connected in seg. 4, narrowly connected in segs. 5 and 6; PD and PL narrow, PL absent in seg. 6. (Whether spots posterior to seg. 3 are yellow or blue is uncertain in the dried specimen.) Seg. 7 similar to 6 but posterior arm of the V-shaped AL is lacking. Seg. 8 with a large triangular ML (?) and PD of similar size and shape. Segs. 9 and 10, ovipositor and appendages black, apparently without light spots except apices of ovipositor sheaths beyond bases of the stylets which are white.

We point out some characters of venation (figs. 6 and 7): fore wing with 22 antenodals, one and eight or nine are strong, 13-14 postnodals:

stigmas surmounting three cells. M_{1a} arises at first R cross vein beyond the sigmatic brace vein. Three or four irregularly arranged rows of cells between branches of fork of Rs which forks 4 R. cells before stigma: Rs again forked 4 cells before the terminal fork with a branch 3 cells long, connecting with the supplementary sector next behind Rs. M_4 completely interrupted just before final bend down to edge of wing. Supratriangle with 4–5 cells, triangle 5 cells, inner triangle 2 cells. Cu_2 with 5 distinct branches.



Aeshna biliosa Kennedy, *allotype female.*

Fig. 6. Left fore wing reversed. 7. Left hind wing reversed.

Hind wing (fig. 7) with 14–15 antenodals, one and eight strong, 16–18 postnodals. M_{1a} arises just before stigmatic brace vein. Two rows of cells between bases of Cu_1 and Cu_2. Two large anal loops (and an outer Cu_2 loop). The basal anal loop of 14 cells with one row of cells between it and hind edge of wing. The second anal loop which also contacts base of Cu_2 with 17 cells. Beyond this a third loop of 19 cells formed by the recurved second branch of Cu_2.

Apex of hind femur reaching base of abdominal seg. 2.

Ovipositor (figs. 3 and 4) short, stylets arising at level of apex of seg. 9. Posterior half of ventral surface of seg. 10 shallowly furrowed along median ventral line and covered with many (75–100?) short sharp spines.

Appendages (cerci) 8 mm. long, while total length of segs. 9 and 10 is 5.5 mm. Appendages oblanceolate, widest at base of outer third where the width is 0.8 mm., outer edge slightly straighter than inner. Apices rounded.

This *allotype* female taken by William Clarke-Macintyre at El Tablon, 2,000 meters elevation, near Baños, Prov. de Tungurahua, Rep. dèl Ecuador. October 28, 1938. Now in the writer's collection.

METHODS OF STATISTICAL ANALYSIS, by C. H. GOULDEN. vii+277 pp., 15 figures and 96 tables. 1939. Published by JOHN WILEY AND SONS, INC., 440 Fourth Ave., New York, N. Y. Price $3.50.

Many entomologists using statistical methods are doubtlessly familiar with the previous mimeoprinted editions of Dr. Goulden's manual, which was one of the first accounts of modern bio-statistics to appear in this country. Few changes or additions are incorporated into the present book, but those which are included are very effective in rounding out the previous material into a comprehensive and well organized text. In particular, the Introduction and Chapter V on The Design of Simple Experiments contain careful explanations of basic notions which are common to all experimental and statistical enquiry and which add greatly to the general continuity. Unworked numerical examples are furnished in almost every section, making the book adaptable either as a text or as a self-instruction guide. A nice balance appears to have been struck between mathematical summarization, verbal explanation, and illustration with numerous and diversified examples. The treatment might be described as concise, but this must not be taken to mean that a full understanding of its contents is to be quickly attained. In fact, the book is expressly designed for research students who already possess some acquaintance with statistical theory, and even for these the required period of study is considered by the author to be a full academic year.

Entomologists will be particularly interested in Chapter XII, The Field Plot Test. Here, in 67 pages, is a very full account of the arrangement and statistical analysis of complex field experiments. Randomized blocks and Latin squares are now in common use, but some of the more complex designs suitable for the evaluation of large numbers of varieties or treatments have probably not yet received the attention which they deserve. These include factorial and quasi-factorial designs, split-plot and incomplete randomized block experiments, all of which are described in detail. Moreover, the underlying principles of *confounding* and *orthogonality* might very well find application with equal effectiveness in complex laboratory tests.

From the entomologist's standpoint, it is unfortunate that more attention is not paid (in this or any other manual now available) to the treatment of complex bodies of enumeration data arising from qualitative variation. Entomological experiments will most commonly involve percentages of mortality, percentages of parasitization, percentages of infestation, etc., and it is frequently a puzzle to decide whether chi-square should be applied in drawing the numerous comparisons or whether, with or without transformation of the percentages, the analysis of variance might validly serve. Expert advice, or perhaps additional methods, would seem to be greatly needed in this phase of the subject.

Chapter headings are as follows: I. Introduction; II. The Arithmetic Mean and Standard Deviation; III. Theoretical Frequency Distributions; IV. Tests of Significance with Small Samples; V. The Design of Simple Experiments; VI. Linear Regression; VII. Correlation; VIII. Partial and Multiple Regression and Correlation; IX. The Chi-Square Test; X. Tests of Fit and Independence with Small Samples; XI. The Analysis of Variance; XII. The Field Plot Test; XIII. Variance Applied to Linear Regression Formulae; XIV. Non-linear Regression; XV. The Analysis of Covariance; XVI. Miscellaneous Applications; Tables of *t*, chi-square, and *F;* Index.—C. W. C.

NEW DOLICHOPODIDAE (DIPTERA)[1]

F. C. Harmston and G. F. Knowlton,[2]
Agricultural Experiment Station,
Logan, Utah

The following report deals with three apparently undescribed Dolichopodidae species. Two of these were present among material received from Canada, and one from South Dakota.

Dolichopus refulgens n. sp.

Male.—Length 5.8 mm.; wing 5.2 mm. Face wide but somewhat narrowed below, short, with the lower one-fourth sharply receding. Front dark green with coppery reflections, dusted with silvery pollen. Antennae (fig. 2) wholly black; third joint but little longer than wide. Orbital cilia entirely black, no light colored cilia or bristles near proboscis; palpi and proboscis black.

Thorax dark green with coppery reflections, anterior margin dusted with grayish pollen, dorsum with two distinct brownish vittae bordering the acrostichal bristles; pleurae dulled with gray pollen. Abdomen dark green with coppery reflections, the hind margins of the segments narrowly darkened and appearing burnished; hairs on abdomen dense, black. Hypopygium black; its lamellae (fig. 3) small, oval, whitish with broad black apical margin which is jagged and bristly, fringed above with long brownish hairs, below with short yellowish hairs.

Coxae and femora black; anterior surface of fore coxae clothed with tiny black hairs. Middle and hind femora each with one preapical bristle, the latter ciliate on apical half of lower inner margin with about six long black cilia, the longest being longer than width of femora, the hairs near base much shorter; fore tibiae yellow; middle pair yellow, infuscated and slightly thickened at tip; posterior pair brownish yellow, black and slightly thickened at tip, bristles on outer and posterior surface large. Tarsi black; first joints of fore and middle tarsi a little yellowed near bases; middle basitarsus with a large bristle above, two slightly smaller ones on the anterior surface and several still smaller ones on the ventral surface; posterior tarsi nearly twice the length of their tibiae. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 1) grayish, more brown along anterior margin and veins; costa slightly thickened at tip of first vein, gradually tapering to its tip; fourth vein scarcely bent near its basal third; hind margin scarcely indented at tip of fifth vein; wing of nearly parallel shape, anal margin evenly rounded, not prominent.

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[1]Contribution from the Department of Entomology, Utah Agricultrual Experiment Station, Logan.

[2]Research assistant and research associate professor of entomology, respectively.

Described from one male taken at Fawcett, Albert, Canada, June 6, 1934, by E. H. Strickland.

Holotype, deposited in the Canadian National Museum.

Taxonomy. This species is related to *packardi* V. D. to which it runs in the Van Duzee and Curran key to males of Nearctic *Dolichopus* (American Museum Novitate No. 683); it differs, however, in being larger, in the absence of any white or yellowish hairs or bristles near the proboscis, in the color of the front and in shape of the wings.

Dolichopus stricklandi n. sp.

Male.—Length 4.8 mm.; wing the same. Face narrow, silvery white. Front shining green, narrowly edged with yellow pollen along the orbits. Palpi yellow; proboscis black. Antennae (fig. 5) black; first joint broadly reddish-yellow below; second and third joints black, the latter twice as long as wide, pointed at tip, pubescent with minute yellowish hairs. Lateral and inferior orbital cilia white, about eight of the upper cilia on each side black.

Thorax dark shining green, the dorsum appearing more bluish; pleurae dulled with grayish pollen. Abdomen bright shining green, the fifth segment distinctly purple. Hypopygium black; its lamellae (fig. 4) moderately large, whitish with broad black apical margin jagged and bristly, these bristles appearing brownish in certain lights.

Fore coxae yellow, anterior surface with minute yellow hairs, the usual black bristles at tip; middle and hind coxae black with narrow yellow tips. Femora yellow, the middle and hind pair each with one preapical bristle, the latter with short yellow cilia on nearly the entire lower inner edge, this cilia not longer than one-third the width of femora. Tibiae yellow; middle pair with one bristle below; posterior pair black at tip for one-fourth their length and slightly thickened. First joint of fore tarsi (fig. 6) blackened at tip, second and third joints entirely yellow but little infuscated at their tips, fourth and fifth joints black, the fourth slightly flattened, the fifth compressed and fringed with short black hairs above, the empodium enlarged and forming a white tip at end of tarsi; middle tarsi black from tip of first joint, which has a large bristle above, two smaller ones on the anterior surface; posterior tarsi black, its joints as 27—19—11—7—5. Calypters and halteres yellow, cilia of the former dense, yellow.

Wings (fig. 7) grayish; costa with an elongated enlargement at tip of first vein; last section of fourth vein bent near its middle; wing widest basally from tip of fifth vein, tapering to root of wing.

Described from one male taken at Gull Lake, Alberta, Canada, July 27, 1932, by E. H. Strickland.

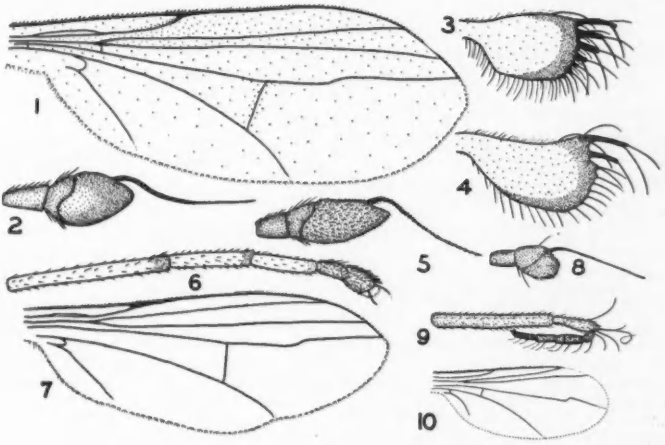
Type in the Canadian National Museum.

Taxonomy. This species runs to *pulmitarsis* Fallen, in the key to males of Nearctic *Dolichopus* (American Museum Novitate No. 683); it differs from that species in that the middle

and hind coxae are black with narrow yellow tips, cilia of posterior femora are shorter, the wing has an enlargement at tip of first vein and the fourth and fifth segments of fore tarsi are more flattened.

Asyndetus severini n.sp.

Male.—Length 2.5 mm.; wing 1.8 mm. Head wider than thorax; eyes large; face and front wide, of nearly equal width, thickly covered with silvery pollen which completely hides the ground color; palpi and



Figs. 1–3. *Dolichopus refulgens* n. sp., male.
Figs. 4–7. *Dolichopus stricklandi* n. sp., male.
Figs. 8–10. *Asyndetus severini* n. sp., male.

proboscis black, the former velvety pilose; antennae (fig. 8) black, third joint of moderate size, rounded at tip, distinctly pubescent; arista dorsal, long, distinctly tapering; inferior orbital cilia and whiskers white, upper orbital cilia black. Thorax and abdomen green with coppery reflection; dorsum of thorax and pleurae dulled with white pollen which nearly hides the greenish-coppery ground color; hair of abdomen black except those at lateral portions of first and second segments, which are longer and snow white; hypopygium black, small with four stout bristles at tip, its appendages scarcely visible. Coxae blue-green with white pollen; hairs and bristles of fore and middle coxae black, hind pair with a strong bristle on outer surface at basal one-fifth; femora blue-green with tips narrowly yellow; all tibiae yellow except apical one-fourth of hind pair which are distinctly infuscated; fore tarsi (fig. 9) blackened from tip of first joint which has several long, curled hairs at tip, second joint one-half length of third, the joints haired approximately as shown in the

figure; middle tarsi browned from tip of first joint; hind tarsi wholly black; fifth joint of middle and hind tarsi flattened dorso-ventrally. Tegulae, their cilia and halteres white. Wings (fig. 10) grayish hyaline; veins dark brown.

Described from one male taken at Martin, South Dakota, July 7, 1924, by H. C. Severin. *Type* in the Utah Agricultural Experiment Station insect collection.

Taxonomy. This species is nearest *appendiculatus* Lw. in general body color and venation but is easily separated from that species by the larger third antennal joint and the peculiar structure of the foretarsi. In *appendiculatus* the first and second joints of fore tarsi are of nearly equal length, while in *severini* the second joint is scarcely one-third the length of the first joint; hairs at tip of second joint are haltere-like in *appendiculatus* but are simple and curled in *severini*.

THE HUMAN VALUE OF BIOLOGY by JOHAN HJORT. Pages xii and 241, 1938. 5.5x8 inches. Published by the HARVARD UNIVERSITY PRESS, Cambridge, Mass. Price $2.50.

Because he is Norwegian, and few Americans contact the intellectual life of Norway on account of the difficulties of language, Johan Hjort is merely a name to the average American biologist. Measured by his studies of marine populations and his services to the various fishing industries of northern Europe, he rates as one of the great biologists of the present time. He developed methods of prophesying the amount of the herring crop each season. He started the prawn fishery from his discovery of these shrimp in deep water in 1897. (Now it has an annual catch of four thousand tons.) His great contributions to the science of biology lie in his study of the fluctuation of populations, in his field, the fluctuations of marine populations. All students seriously studying the extent, density and fluctuation of populations have to familiarize themselves with Hjort's research on fish populations in northern Europe.

"The human value of biology" is a series of lectures given first (1936) at the University of Oslo and revised later at Harvard. To the writer the volume is fascinating in the many ideas brought together from that part of philosophy which deals with the technique of logical thought and from the application of this technique to the methods and philosophy of biology. The lectures were given with two objects: 1. To impress on his students the necessity of accepting scientific method as the approach to their biological studies, and 2. To advertise the importance of biological ideas for the guidance of practical and social life. After a few pages of Hjort we wonder how soon we can ignore students, Deans and even Trustees and go on a reading debauch from Aristotle to Immanueal Kant, from Adam Smith and Malthus to Raymond Pearl. Hjort's richness of exposition reminds one of some of Wm. M. Wheeler's essays.

The titles of chapters are: I. Philosophy and Research; II. The Renaissance; III. Biological Philosophy of the Renaissance; IV. Analogies of Experience; V. The Study of Life; VI. The Meaning of Species; VII. Mental and Physiological Experience; VIII. Biology and the Science of Population; IX. Biology and Social Science; X. Sociology in the Light of Biology, and Epilogue.

After pages of notes while reading, and we have read this volume word for word from cover to cover, we will not single out any one item for comment. There are too many possibilities. Our only criticism might be that it is too rich. One cannot enjoy life on mince pie or fruit cake alone. We have been more than one year in our digestion of this unusual book.—C. H. K.

ELEVEN NEW AMERICAN COLEOPTERA

(Scarabaeidae, Cicindelidae)

O. L. CARTWRIGHT,[1]
South Carolina Agricultural Experiment Station,
Clemson, South Carolina

Phyllophaga ovalis n. sp.

Holotype male.—Length 19 mm., width 11 mm. Oblong oval, shining, glabrous, dark castaneous, head darker. Antennae 10-jointed, rufotestaceous, club slightly longer than the stem. Clypeus emarginate; margin moderately reflexed; punctures moderately coarse, evenly distributed, close, separated by their diameter or less; suture sinuate, slightly impressed. Head impunctate along suture and occiput; front slightly convex, punctures about as on clypeus, the punctures separated by one diameter across middle, to two diameters or slightly more anteriorly and posteriorly. Pronotum convex, three-fourths wider than long; sides subangulate, widest at middle, straight converging anteriorly, sinuate slightly converging posteriorly; side margins irregularly crenate; all angles distinct, right; base sinuate, impressed margin obsolete middle third; punctures much coarser than on head and clypeus, irregularly and more widely spaced, separated by two to four or more diameters; no indication of median smooth line. Elytra and scutellum strongly punctured, punctures more evenly distributed, closer and somewhat finer than on thorax; sutural costae distinct, others obsolete. Mesosternum with fine yellowish hair, fine punctures. Abdomen glabrous, minutely punctulate especially at sides, with a shallow longitudinal impression. Penultimate segment with a few moderate punctures at sides, a shallow but distinct transverse smooth depression at posterior third. Terminal segment transversely shallowly impressed. Pygidium very finely obsoletely punctured, almost smooth. Fixed spur very short, acute; upper thin, lanceolate, slightly curved, subacute. Tooth of claw median, strong, right angled. Aedeagus, Fig. 1.

Female unknown.

Holotype taken at light "in dry turkey oak," 4.7 miles west of Niceville, Florida, June 7, 1938, by F. N. Young. Two *paratypes* from DeFuniak Springs, Walton Co., Fla., June 5, 1934, T. H. Hubbell. Maximum length of paratypes 21.5 mm., width 11.5 mm. Holotype deposited in U. S. National Museum. Paratypes in collections of Dr. M. W. Sanderson and Dr. Philip Luginbill.

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[1]Technical Contribution No. 66 from the South Carolina Agricultural Experiment Station, Clemson, South Carolina.

Ph. ovalis is very close to *Ph. infidelis* (Horn) but the antennal club is longer and lighter in color, the pubescence of the mesothorax is ochreus, rather than gray, the lateral margins of the thorax are not so distinctly crenate, the elytra are strongly punctured with no tendency to rugulosity, and the aedeagus is distinctly different.

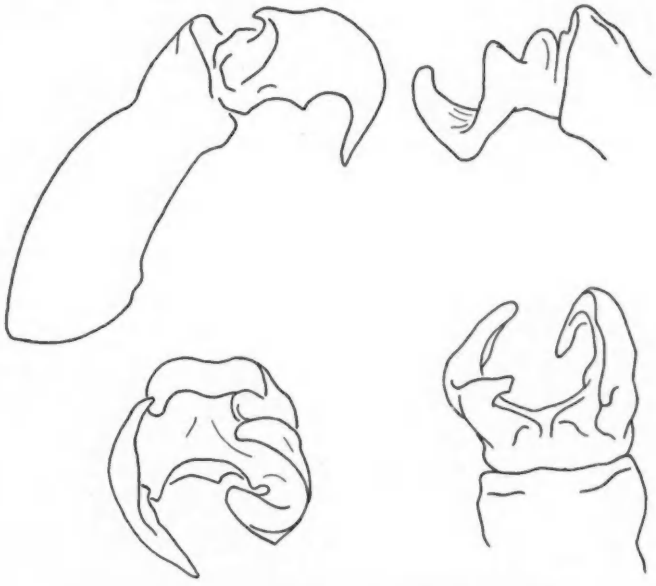


FIG. 1. Aedeagus of *Phyllophaga ovalis* Cartwright.

Aphodius goffi n. sp.

Holotype male.—Length 7.5 mm., width 3.5 mm. Moderately elongate, reddish brown, shining. Antennae a little paler. Head moderately convex, obsoletely tuberculate each side, smooth, minutely punctulate under medium magnification; clypeus broadly feebly emarginate, distinctly angulate each side, the sides arcuate, fimbriate, and very gradually moderately reflexed; genae not prominent, obtuse, rounded from the anterior border of the eye to the front. Thorax about half again as wide as long, the sides feebly arcuate and gradually narrowed to sharply rounded anterior angles, margin fimbriate, not explanate, hind angles obtusely rounded, base sinuate and with fine marginal line; disc moderately convex, minutely punctulate with a few scattered fine to moderate punctures at sides. Elytra a little narrower than the thorax at the base, the humeri obtuse, sides feebly arcuate, disc mod-

erately deeply striate, striae closely and finely punctured, intervals flat, smooth. Mesosternum not carinate, alutaceous and punctulate except for smooth space at middle. Metasternum smooth at middle, setigerously moderately punctured especially anteriorly at sides, a row of four or five close coarse punctures each side forming a wide v at posterior coxae. Abdomen finely punctured, punctures bearing fine decumbent hair. Anterior tibiae smooth in front, tridentate, the teeth long, subacute; not crenulate above; first tarsal joint shorter than the second. Posterior femora with three or four coarse punctures near the knee, the tibiae fimbriate with unequal spinules, the first tarsal joint as long as next three together.

Allotype female.—Length 8 mm., width 4 mm. I find no external characters by which the sexes may easily be distinguished.

The 65 specimens of the typical series vary in length from 7.3 to 9 mm., and in width from 3.5 to 4 mm. The fine punctulation of the thorax becomes almost imperceptible in some individuals.

Holotype taken by C. C. Goff in a burrow of the Florida pocket gopher (*Geomys floridanus* A. and B.) at Eau Gallie, Florida, May 1, 1938. *Allotype female* from gopher burrow at Newman's Lake, Alachua Co., Fla., by H. K. Wallace, June 24, 1938. *Paratypes* trapped in gopher burrows at Leesburg, Eau Gallie, Dug Creek (Hillsboro County) and Newman's Lake (Alachua Co.) by C. C. Goff and H. K. Wallace, March 31, 1938, to August 16, 1938. One specimen, Gainesville, Fla., September 16, 1922, Alexander-Walker, University of Michigan Collection.

Aphodius goffi superficially resembles *concavus* Say and *fucosus* Schm. (*rubidus* Lec.) and keys to the same group. The angulate clypeus especially resembles that of *fucosus* but the lack of prominent genae and the extremely fine punctulation of the head and thorax easily distinguishes *goffi* from both.

Holotype and allotype deposited in United States National Museum. Paratypes placed in collections of: Florida Experiment Station, Florida Plant Board, University of Florida, Museum Comparative Zoology, Philadelphia Academy of Science, California Academy of Science, Snow Museum, University of Kansas, Ohio State University, University of Michigan, Natural History Survey of Illinois, Canadian National Museum, British Museum, and the private collections of H. C. Fall, H. K. Wallace, M. A. Cazier, M. W. Sanderson, C. A. Frost, Mark Robinson and the writer.

Aphodius geomysi n. sp.

Holotype male.—Length 4.5 mm., width 2.2 mm. Elongate elliptical, rufotestaceous, shining. Antennae testaceous. Head moderately convex, four-fifths as wide as thorax, front not tuberculate, finely punctulate; clypeus broadly shallowly emarginate and impressed, a few longitudinal wrinkles, the sides including genae evenly arcuate to anterior margin of the eye, genae fimbriate. Thorax half again as wide as long, widest at base, sides feebly arcuate, not explanate, not fimbriate, all angles distinct, base finely margined, broadly evenly arcuate, sinuate to hind angles; disc finely punctulate, sides with close coarse punctures from anterior third to base. Elytra slightly narrower at base than thorax, sides arcuate, widest at basal third; disc finely rather shallowly striate, striae punctate; intervals minutely punctulate, flat on disc, slightly convex at apex. Mesosternum carinate between the coxae, finely closely punctate, smooth at middle. Metasternum sparsely punctulate at middle, alutaceous and sparsely granulate at sides. Abdomen alutaceous, variably punctate, a row of large punctures across each segment, smaller punctures irregularly placed, punctures bearing fine hair. Anterior tibiae punctate on anterior face, tridentate, the teeth long subacute, not crenulate above, first joint of tarsus longer than second. Middle and posterior femora with a few coarse setigerous punctures near knee; hind tibiae fimbriate with unequal spinules, first tarsal joint slightly shorter than next three together.

Allotype female.—Length 4.3 mm., width 2.1 mm. The group of coarse punctures at the sides of the thorax are smaller, fewer in number, and less closely spaced than in the male.

The 70 specimens of the typical series vary in length from 4.2 to 5 mm., in width from 2 to 2.6 mm. The coarse punctures of the thorax vary from sparse, separated by one to four or more diameters in some specimens, to dense, separated by less than one to two diameters in others.

Holotype collected by H. K. Wallace at Newman's Lake, Alachua Co., Florida, June 28, 1938. Allotype female taken at Eau Gallie, Florida, August 9, 1938. Paratypes from Eau Gallie, May 1 and August 9, 1938, C. C. Goff; Lake Streaty, Polk Co., August 10, 1938, C. C. Goff; Marianna, April 23, 1938, C. C. Goff; Gainesville, March 18, 1923, University of Michigan Collection; August 21, 1922, J. B. Merrill; July 6, 1938, H. K. Wallace; and Newman's Lake, Alachua Co., June 28, July 2, 1938, H. K. Wallace.

Aphodius geomysi is placed in Horn's group Ib as revised by W. J. Brown (Canadian Entomologist LIX, 1927, p. 163) and keys out to *Aphodius cavidomus* from which it is separated by its larger size, greater convexity, and peculiar elliptical shape. This species is another of the several remarkable

insects found inhabiting the burrows of the Florida Pocket gopher by the late Mr. C. C. Goff.

Holotype and allotype deposited in the United States National Museum. Paratypes distributed to same collections as *Aphodius goffi*.

Aphodius windsori n. sp.

Holotype.—Length 3.5 mm., width 1.7 mm. Oblong oval, convex, piceous, shining. Antennae testaceous. Clypeus bidentate, the teeth distinct, triangular, subacute, the distance between them two-thirds that from the teeth to the external angles of the moderately prominent genae; emarginate between the teeth, the sides arcuate; obsoletely granulate in front, finely punctate. Head feebly tri-tuberculate, finely punctate, the punctures separated by two to four diameters. Prothorax convex, slightly more than three-fourths as long as wide, sides feebly arcuate, converging anteriorly from basal angles; angles distinct, obtusely rounded; basal margin sinuate, finely margined; disc finely evenly punctate, punctures separated by three or four diameters, punctures closer, larger, tending to two sizes at sides, particularly toward anterior angles. Elytra convex, about a third longer than wide; striae deep, strongly crenately not closely punctured, first five reaching margin; intervals flat to feebly convex at apex, finely sparsely punctate. Mesosternum not carinate between the coxae, alutaceous except at middle, coarsely punctate. Metasternum sparsely punctate, the punctures larger anteriorly at sides. Abdomen alutaceous, with very shallow coarse punctures bearing very fine semi-decumbent hair; the terminal segment normal. Anterior tibiae smooth in front, tridentate, crenate above upper tooth, second joint of tarsus three times length of first. Middle and posterior femurs finely punctate, a row of three or four close coarse punctures at knee. Hind tibiae fimbriate with short equal spinules, long spur longer than first joint of tarsus which equals next two together. Sex not determined.

Holotype taken at Windsor, South Carolina, November 25, 1938, O. L. Cartwright, deposited in U. S. National Museum. One *paratype*, same data, in author's collection. Paratype differs in somewhat finer punctation throughout. Closely allied to *Aphodius crassulus* and the following species.

Aphodius brimleyi n. sp.

Holotype male.—Length 3.3 mm., width 1.5 mm. Oblong oval, strongly convex, piceous, shining. Antennae testaceous, the club darker, grayish. Clypeus bidentate, the teeth distinct, triangular, subacute, the distance between them subequal to that between the teeth and the external angles of the moderately prominent genae; scarcely emarginate in front, the sides straight; distinctly granulate anterior to a feeble clypeal ridge, smooth along edge. Head feebly tri-tuberculate, alutaceous and finely punctate anterior to frontal suture, more coarsely

punctate posteriorly, the punctures separated by one to two diameters. Prothorax convex, a third wider than long, widest at base, sides slightly arcuate, all angles obtuse but distinct, basal margin sinuate, finely margined, disc evenly punctate with intermixed moderate and coarse punctures, the larger two to four times as large as the smaller, separated on average by about the diameter of the larger, noticeably closer at sides except on median smoother area. Elytra very convex, about a third longer than wide; striae one-seventh as wide as widest interval, not closely, crenately punctured; intervals flat, scarcely convex even at apex, finely sparsely punctulate, the punctures mostly in a row each side near striae. Mesosternum not carinate between the coxae, alutaceous except at middle, coarsely punctate. Metasternum with sparse moderate punctures at middle, becoming alutaceous and the punctures becoming closer, deeper, and coarser anteriorly at the sides. Abdomen alutaceous, with very shallow coarse punctures and very fine yellowish semi-decumbent hair, the terminal segment with a distinct rounded median depression, the posterior edge elevated medially and accentuating the depression. Anterior tibiae smooth in front, acutely tridentate, crenate above upper tooth, second joint of tarsus three times length of the first. Middle femora with three or four coarse punctures at knee. Posterior femora finely punctulate throughout but lacking the coarse punctures at the knee; hind tibiae fimbriate with short equal spinules, long spur as long as first joint of tarsus which equals next two together.

Allotype female.—Length 4.4 mm., width 2.0 mm. I find no external characters by which the sexes may easily be separated.

The 131 specimens of the typical series vary in length from 3.3 to 4 mm., and in width from 1.5 to 2.25 mm. The middle frontal tubercle is binodose in many specimens. A more or less evident impunctate median line may be traced on the thorax in some individuals.

Holotype and *allotype* taken in Pisgah Forest (near Brevard entrance), North Carolina, June 28, 1938, in deer droppings, by O. L. Cartwright. *Paratypes* from same locality, July 1, 1937, by J. A. Berly, and March 15, April 29, May 25, June 28, July 1, August 2, and September 10, by O. L. Cartwright. Also from Sassafras Mtn., Rocky Bottom, Pickens Co., South Carolina, June 26, 1934, in sheep manure, by O. L. Cartwright. The Pisgah Forest specimens were found in association with *Ataenius carolina* Van Dyke, *Dialytella dialytoides* Fall, and the three species of *Dialytes*, *striatulus* (Say), *truncatus* (Melsh), and *ulkei* Horn.

Holotype deposited in United States National Museum. Paratypes in collections of: North Carolina Department of Agriculture, Museum of Comparative Zoology, Philadelphia Academy of Science, California Academy of Science, Snow Museum, University of Kansas, Ohio State University, Uni-

versity of Michigan, Canadian National Museum, British Museum, and private collections of H. C. Fall, M. A. Cazier, M. W. Sanderson, L. W. Saylor, Mark Robinson, C. A. Frost, and the writer.

Aphodius brimleyi, which is named in honor of Dr. C. S. Brimley, North Carolina entomologist and naturalist, is closely allied to *Aphodius crassulus* Horn and keys to that species in Horn's 1887 monograph of the Aphodiini. The eastern species of the *Aphodius crassulus* complex thus far known are easily separated. *Aphodius odocoilus* Robinson may be recognized by the concave intervals of the elytra, an unusual condition especially noticeable at the shoulders and by its very small size, 2.7 to 3.7 mm. *Aphodius brimleyi* Cartwright may be known by its very convex form, comparatively coarse mixed punctures of the thorax and particularly by the concavity of the terminal abdominal segment. *Aphodius windsori* Cartwright is distinguished by its flatter, more parallel form, much finer punctation, the five inner striae attaining the margin, and the intervals nearly flat at the apex. *Aphodius crassulus* Horn., the largest species, 3.5 to 6 mm., is very convex, the anterior tibiae have a row of punctures over the basal half along the inner edge of the anterior face, the elytral striae become wider and the intervals strongly carinately convex at the apex.

Aphodius robinsoni n. sp.

Holotype male.—Length 4.1 mm., width 1.8 mm. Elongate, convex, piceous, shining. Antennae sooty. Head four-fifths as wide as thorax, not tuberculate, coarsely densely punctate, the punctures alutaceous within under magnification; the clypeus similarly punctate, the punctures tending to coalesce and the alutaceous sculpture more noticeable across the convex disc; shallowly emarginate, slightly depressed, an acute tooth each side; sides sinuate, the middle portion sharply reflexed, genae prominent, depressed. Thorax three-fourths as long as wide, sides parallel with a barely noticeable sinuation along posterior half, slightly converging anteriorly, all angles distinct and obtusely rounded, coarsely densely punctate throughout as on head; basal marginal line distinct, entire. Scutellum small, coarsely punctured except at apex. Elytra two-thirds as wide as long, roughly and peculiarly sculptured, the striae deep, about half as wide as the intervals, shining and smooth between transverse punctures spaced one and one-half times the width of the striae, giving the striae a ladder-like appearance; the intervals sharply carinate at middle, with a row of coarse close-set punctures each side on a flat shoulder at a level midway between the bottom of the striae and the upper edge of the carina. Mesosternum not carinate between coxae; metasternum, middle and posterior femora coarsely very closely

punctate, the punctures alutaceous, and each bearing a fine very short hair. Abdomen alutaceous, obsoletely granulate. Anterior tibiae smooth in front except for a row of close fine punctures along inner edge, acutely tridentate, crenate above the teeth, first tarsal joint shorter than second. Posterior tibiae fimbriate with unequal spinules; first tarsal joint slightly shorter than next three together.

Female unknown.

Six specimens vary in length from 3.5 to 4.25 mm., and in width from 1.7 to 2.15 mm. I find no other significant difference.

Holotype taken at Mt. Misery, New Jersey, September 12, 1938, in deer droppings, by Mark Robinson, deposited in United States National Museum. *Paratypes* from the same locality, October 11, 1937, by O. L. Cartwright; September 12, 1938, by Mark Robinson; and April 18, 1938, one specimen reared from a larva found in deer droppings, March 7, 1938, by L. J. Bottimer. Paratypes in collections of the above named collectors.

Aphodius robinsoni, which is named in honor of Mark Robinson, who carried the writer to the locality where the first specimen was found, keys to Horn's group K, but differs from all species in that group by the peculiar sculpture of its elytra.

Ataenius saramari n. sp.

Holotype.—Length 2.9 mm., width 1.5 mm. Oblong oval, convex, piceous, glabrous, shining. Antennae rufotestaceous. Head two-thirds as wide as prothorax, convex, a few moderate punctures across occiput where they are separated by two to three diameters, front and clypeus with regularly placed sparse fine punctures separated by four or more diameters. Clypeus moderately emarginate, depressed, the sides rounded, a wide shallow groove extending laterally each side from the median depression causing the sides to appear slightly explanate; genae obtuse, not prominent. Thorax two-thirds as long as wide, convex, evenly moderately punctate, the punctures becoming slightly smaller anteriorly and closer at the sides, particularly in the anterior angles, fine very sparse punctulation between the larger punctures which are separated on the disc by one or two diameters; sides sub-parallel, angles rounded but distinct, marginal line fine, distinct, fimbriate. Elytra four-fifths as wide as long, base narrower than thorax, humeri finely dentate; striae as wide as largest thoracic punctures, deep, crenately punctured; intervals moderately convex with a medial row of extremely fine punctures, becoming strongly convex to subcarinate over apical third and the fine punctures becoming slightly larger; sides arcuate, the edges fimbriate, crenate. Mesosternum strongly carinate between the coxae, very closely punctate, the punctures bearing very fine short hair. Metasternum with a deep median longitudinal sulcus, otherwise nearly smooth at middle, a transverse submarginal eroded area above the

coxa. Abdomen with irregularly placed shallow punctures, somewhat coarser at sides, the segments crenate in front. Anterior tibiae tridentate, not crenate above, first tarsal joint as long as next two together. Posterior femur smooth except for two or three large punctures at the knee, the marginal line deep and entire; posterior tibiae without accessory spinule, first tarsal joint subequal to next four together. Sex not determined.

Holotype taken in Geomys burrow at St. Cloud, Florida, August 8, 1938, by T. H. Hubbell, deposited in U. S. National Museum. While taken in a Florida pocket gopher's burrow, its presence there was probably only an accident, since its general appearance is not that of an indigenous species.

The unique holotype lacks one antennae, one entire fore leg, the tibia and tarsus of one posterior leg, and the tibial spurs of all remaining legs are broken. *Ataenius saramari* keys to *ovatulus* in Horn's 1887 monograph. It differs in its smaller size, minor details, and especially in the fimbriate crenate edge of the elytra.

Diplotaxis nigra n. sp.

Holotype male.—Length 12 mm., width 6 mm. Moderately elongate, parallel, black, elytra minutely alutaceous, feebly shining. Mentum flat posteriorly, declivous from about anterior third, margin of declivety raised and bearing a row of erect setae. Head closely moderately punctate, the punctures separated by less than their diameters; clypeus broadly feebly sinuate at middle with rounded angles; suture straight, impressed, the adjacent surface of front narrowly smooth; post-clypeal convexity evident, the front feebly bi-impressed. Prothorax convex with a fine median longitudinal impressed line almost entire length; four-sevenths as long as wide; sides arcuate, anteriorly converging, subparallel over basal half; posterior angles slightly obtuse, front angles scarcely prominent, not impressed; punctures moderate as on head, evenly distributed separated by one to three diameters on disc, becoming closer, not so deep and slightly larger at the sides. Elytra slightly more than two-thirds as wide as long, three times as long as thorax; sutural costae only slightly convex, with irregularly placed fine punctures separated by two to four diameters; discal costae distinctly defined, flat, with single row of fine punctures; intercostal areas with moderate confused punctures separated by one to three diameters, the first about three times as wide as sutural costa, the second two-thirds as wide as the first. Punctation beneath fine and sparse at middle, coarser and closer at sides. Pygidium confusedly, moderately coarsely punctate, each puncture bearing a short fine yellowish hair; a median impressed line faintly indicated. Upper tooth of anterior tibiae submedian in position, perhaps a trifle nearer the apex than the base. Ungual tooth strongly post-median, its tip more than twice as far from the base as from the tip of the claw.

Allotype female differs in having shorter tarsi and a relatively narrower pygidium. Fourteen paratypes vary in length from 11 to 12.5 mm., and in width from 6 to 6.7 mm.

Holotype and *allotype* collected at Hinton, Oklahoma, June 13, 1937, by John Standish and R. W. Kaiser, deposited in U. S. National Museum. Paratypes, same data, and from Broken Bow, Oklahoma, June 27, 1937, Standish-Kaiser, deposited in collections of Oklahoma A. & M. College, H. C. Fall, M. A. Cazier, Mark Robinson, and the writer.

Diplotaxis nigra is very similar to *tristis* Kirby but differs in that it is not quite so shining, the thorax is not as short and bears a long impressed median line, the sutural costae of the elytra are not as finely punctate, and the third tooth of the anterior tibia is submedian.

Polyphylla pubescens n. sp.

Holotype male.—Length 19 mm., width 10 mm. Elongate oval, head and thorax black, elytra brown, legs and underparts dark castaneus. Antennal club of seven lamellae, longer than scape, slightly longer than width of the clypeus; club brownish testaceous, scape dark castaneus. Last segment of maxillary palpi excavated on outer surface. Clypeus nearly twice as wide as long, angles broadly rounded, anterior third slightly reflexed, the margin narrowly abruptly reflexed; closely moderately punctate at base, more sparsely and coarsely so approaching anterior third, which as at the sides is finely and densely punctate; clothed with extremely fine short semi-erect hair; clypeal suture fine, sinuate. Head closely very moderately punctured along clypeal suture, the punctures finer and less close over the front; clothed with very fine erect yellowish brown hair; occipital margin smooth shining. Pronotum three-fifths as long as wide, widest at middle, subparallel and sinuate to base, convergent to rounded anterior angles, posterior angles sharply rounded, the base laterally and the sides narrowly abruptly reflexed; base sinuate, the median lobe finely notched at middle; disc convex but with a shallowly depressed area across anterior fourth which widens posteriorly at lateral third, two large median narrowly separated rounded depressions one behind the other, one or both of which may possibly have resulted from accidental external pressure; closely finely punctate and clothed with very fine decumbent brownish yellow hair, except over a small smooth depressed fovea each side. Scutellum circularly rounded, closely punctate, clothed with short fine hair. Elytra 2.8 times as long as thorax, finely densely punctate, clothed throughout with very fine short decumbent hair except on the shining sparsely punctate humeral and subapical umbones; sutural costae well developed, four obsolete discal costae barely discernible on each elytra. Abdominal segments connate, each widely smooth anteriorly at middle, very finely densely punctate posteriorly and at the sides, the punctures as usual with extremely fine short decumbent

hair. Pygidium convex, sides straight, narrowly reflexed, rather sharply rounded apically, finely punctate, with short decumbent hair. Anterior tibiae acutely bidentate. Claws normal except that in all cases the tooth of the inner claw is only half as long as that of the outer claw.

Female unknown.

Holotype taken 4.7 miles west of Niceville, Florida, June 7, 1938, by F. N. Young. The unique holotype, the only specimen known, deposited in U. S. National Museum.

Polyphylla pubescens differs from other species in its very fine silky pubescence and in the lack of scales and all traces of the usual vittae.

Chlorixanthe chapini n. sp.

Holotype male.—Length 18 mm., width 9 mm. Oblong elongate, flattened, glabrous. Color testaceous with a median longitudinal greenish black strip covering the head, clypeus excepted, a roughly pentagonal shaped area over middle half of the pronotum, the scutellum and the sutural costae of the elytra; thoracic underparts largely greenish black; abdomen, pygidium and legs testaceous, the tibial spurs and tarsal joints apically edged with black. Antennae very moderate. Eyes quite large. Clypeus quadrate, truncate, disc convex, a depressed area each side, the anterior margin reflexed, nearly smooth. Head slightly less than one-half as wide as pronotum, moderately punctate, the punctures becoming much coarser and closer approaching the occiput. Pronotum seven-tenths as wide as long; disc finely punctate, punctures separated by five to ten diameters, closer and slightly larger medially in front and posteriorly at sides, the punctures at anterior angles becoming coarse and somewhat elongate or crescentric; sides subangulate a little before the middle, straight to anterior angles, slightly sinuate to broadly rounded posterior angles, imperfectly margined anteriorly, finely margined posteriorly; base strongly sinuated by scutellum, the angles each side not produced. Scutellum elongate, slightly more than six-tenths as long as pronotum, sides sinuate, apex narrowly rounded; a group of moderate punctures each side at base, otherwise smooth. Elytra three-fourths as wide as long; striae delimiting the sutural costae double over middle two-thirds between scutellum and apex; no discal costae; a few large elongate annulate punctures indicate remnants of next three striae over a very short middle distance on the disc; other striae indicated by rows of widely placed fine punctures; the punctures of rows on the flanks larger and deeper. Mesosternal process between coxae flat, glabrous, slightly rhomboid with rounded sides. Mesosternum smooth at middle, close interlacing incised lines and moderate yellowish pubescence at sides. Abdomen glabrous, a relatively deep longitudinal impression over first four segments, terminal segment with a few moderate punctures medially, penultimate with a posterior submarginal row of close moderate punctures, other segments with a few fine submarginal punctures across the depression. Pygidium with irregularly placed crescentric moderate punctures. Legs robust, the four posterior

tibiae with an acute post-medial tooth on outside, apex with three elongated teeth. Anterior tibiae with three short teeth, the two lower close together and jointly produced, the other slightly post-medial. Tarsal joints compacted; the posterior tarsi and tibiae subequal in length, the middle tarsi a third longer than the tibiae.

Allotype female.—Length 17 mm., width 8 mm. Differs from male in that clypeus is closely punctate, the punctures moderately fine, separated by one to two times their diameter; the remnants of discal striae of the elytra are much longer and the annulate punctures tend to merge into double line as along sutural costae; in addition to the strial punctures, very fine irregularly placed punctures are evident throughout; the punctures of the pygidium tend to form incised wavy anastomosing lines; the first four abdominal segments show shallow impressions medially along posterior edges; and the tarsi are comparatively shorter, the posterior tarsi being shorter than the tibiae.

Holotype taken in Big Bend Park, Brewster Co., Texas, June 17, 1937, by Rollin H. Baker. *Allotype* and two *paratypes* same data except that they were taken on the 12th, 13th and 17th of June. Holotype and allotype placed in United States National Museum; paratypes in writer's collection. Named in honor of Dr. E. A. Chapin, of the U. S. National Museum. Dr. Chapin states he has seen a specimen from Hidalgo, Mexico.

Chlorixanthe flavoviridis Thomson, the only other known species in the genus, differs from *Chlorixanthe chapini*, aside from color and markings, by having the head more sparsely and finely punctate, the anterior angles of the thorax simply punctate, the sides of the thorax widely margined, and the sutural striae and traces of discal striae of the elytra much less developed. The base of the pronotum is said to be angularly produced on each side of the median emargination in *flavoviridis*. My single specimen of this species, while angulate, is not produced, being only slightly more angulate than our common *Euphoria fulgida* (Fab.).

Cicindela abdominalis var. **floridana** n. var.

Differs from *abdominalis* in the shining green color of head, thorax, and elytra, the latter with purplish reflections posteriorly at the sides, and in the strong deep punctures and fovea of the elytra. The green color will also separate this variety from the variety *scabrosa* Schaupp.

Holotype and 20 paratypes collected at Miami, Florida, August 9–12, 1934, by Frank N. Young. *Holotype* deposited in U. S. National Museum, *paratypes* in collections of California Academy of Science, Museum of Comparative Zoology at Harvard, and in private collections of F. N. Young, W. M. Gordon, M. A. Cazier, J. W. Angell, and the author.

NEW SYRPHIDAE (DIPTERA) FROM CENTRAL AND NORTH AMERICA

C. L. Fluke,
University of Wisconsin,
Madison, Wis.

The new forms from Mexico were collected by Professor Harvey G. Meyer of the University of Tennessee, and I wish to thank him for the donation of the specimens. The types of all species are deposited in the American Museum of Natural History, New York City. Paratypes, when available, are retained in the collection of the author.

Syrphus currani, new species

(Fig. 1)

Legs yellow; second and third cross bands on the abdomen entire; tiny bristles on the undersides of the mesatarsi reddish. Length, 11 to 12 mm.

Male.—Face, cheeks, and frontal triangle shining yellow, thinly whitish pollinose along the eyes and on the upper half of the frontal triangle; a small reddish to black spot just above each antenna. Pile of face and cheeks yellowish white, black on the frontal triangle and on the face opposite the antennae. Vertical triangle black with black pile; occipital cilia black but all the straighter hairs of the occiput white. Eyes bare. Antennae brown, more yellowish beneath each segment, third segment rounded at the end; arista brown.

Thorax dark, dulled on the mesonotum by brownish pollen which thins out laterally but becomes heavier on the sides across the notopleura; the postalar callosities shining; pleura lightly pollinose; pile all yellowish. Scutellum dull yellow, pile mostly black, a few yellow hairs basally. Metasternum bare.

Legs yellow; coxae, trochanters, and apical segments of the hind tarsi black; the hind femora and tibiae more reddish; pile all yellow except on the outer sides of the hind femora and tibiae and the upper sides of the hind tibiae.

Wings hyaline, stigma yellowish brown, the base and marginal cells dilutely yellowish. Squamae and halteres yellow, the plumule white. Disc of squamae pilose.

Abdomen semi-opaque black with yellow markings similar to *opinator* O. S.; first pair of spots wider than the following bands, attenuated, and reach the sides and base of the tergite; fore margin of the yellow band on the third tergite nearly straight and just reaches the side margins, rear margin biconvex, yellow band on the fourth tergite similar but narrower; apex of the fourth and fifth tergites yellow. Genitalia reddish, more yellowish underneath. Venter yellow, discs of

second and third sternites dusky; all the erect pile yellow, depressed short pile sparse and black.

Female.—Very similar to the male, the front shining yellow on lower third, lightly but broadly brownish pollinose across the depression, the pile all black; no indication of a brownish ring on the hind femora. Abdominal bands straighter and reach the sides in half their width.

Types.—Holotype, male, Logan Canyon, Utah, July 25, 1937 (G. F. Knowlton, C. F. Smith, and F. C. Harmiston); allotype female, Tobela, Utah, August 20, 1937 (L. L. Hansen). Paratypes: 2 males same place as holotype, July 11, 1937 (Knowlton and Harmiston); 1 male same place, June 20, 1937 (W. P. Nye); 1 male, Drakes Peak, Lake Co., Oregon, July 25, 1932, 8600 ft. elevation (D. K. Frewing). Paratypes in the collection of the Utah Agricultural College, Logan, and the author.

This species can be separated from *knabi* Shannon by the shape of the abdominal bands and the rounded antennae, from *opinator* O. S. by the yellow legs and reddish bristles on the mesatarsi. The abdominal bands on the male very closely resemble those of *opinator* O. S., while those on the female are more like *ribesti* L.

Platycheirus normae, new species
(Figs. 2 and 3)

Abdomen reddish, only the posterior margins narrowly black. Legs yellow, pile all pale, on the male a tuft of white hairs at base of front femora, front tibiae broad with a prominent median ridge on the outer surface. Length 7 to 7.5 mm.

Male.—Head brownish pollinose; thinner over the low tubercle, the upper mouth edge, a spot between the eyes and oral opening, and immediately above the antennae; pile all yellowish brown, a few black hairs on the frontal triangle and around the anterior ocellus. Antennae black, third segment broader than in related species; arista brown.

Thorax shining aeneous, almost brassy in reflected light, light brownish pollinose anteriorly on the dorsum and on the pleura, pile all golden brownish.

Legs reddish yellow, only the coxae black, occasionally the trochanters darker. All the pile yellowish to golden in color. A tuft of long curved yellowish hairs at the base of the front femora, followed by 5 or 6 stout yellow hairs, no other peculiar hairs present on the legs. Front tibiae scapula shaped, the blades yellowish white; front basitarsus elongate, wider at the immediate base, white.

Wings luteous hyaline. Squamae yellow, halteres reddish.

Abdomen reddish yellow; first segment shining black, grey pollinose on the sides; apices of the second, third, and fourth tergites narrowly black, slightly wider at the middle than on the sides, emitting a faint median vitta on the second tergite. Genitalia shining black, lightly pollinose. Venter reddish.

Female.—Front thickly pollinose, shining only in front of the ocellar triangle. Front femora at the base with a short open tuft of yellowish hairs; these hairs are not curved and are much shorter than on the male. Apical black markings of abdomen triangular, each emitting a median black vitta which scarcely reaches the anterior margin of the tergites.

Types.—Holotype, male, and allotype, female, Door County, Wisconsin, August 1, 1926 (C. L. Fluke). Paratypes, 4 males, same data as holotype; 1 male, Rice Lake, Wisconsin, August 25, 1912 (A. C. Burrill); 1 male, Fish Creek, Wisconsin, August 13, 1928 (C. L. Fluke); 3 males, Arnprior, Ontario, August 20, 1930 (C. H. Curran); 1 female, Door County, Wisconsin, August 13, 1928 (J. H. Roberts); 1 female, Hull, Que., July 28, 1920 (J. McDunnough).

This species will be readily recognized by the reddish legs and color of the abdomen. Superficially it resembles most *immarginatus* Zett. and *modestus* Ide. It is probably closest to *modestus* but that species lacks the white hairs on the femora and the tibiae are entirely different. The prominent ridge along the length of the front tibiae of *normae* is quite characteristic. The Door County specimens were all taken from reeds along the shore of Nicolet Bay about two miles north of Fish Creek.

Pyrophaena digitalis, new species

(Figs. 4 and 5)

Related to *granditarsus* Forst., but the front basitarsi of the female dilated; abdomen blackish, broadest at the apex.

Female.—Head shining-black; sides of face lightly, but broadly pollinose; pile black above, white below; tubercle more prominent than the mouth edge; cheeks pollinose with white pile. Front narrowing above, shining, with a pair of small triangular side dust spots, pile black. Pile of the occiput yellow above, white below, the cilia all pale.

Thorax shining aeneous black, almost dark blue-black on the pleura, practically devoid of pollen; the pile all pale yellow, whiter on the disc of the mesonotum.

Legs yellow, black as follows: coxae, trochanters, a broad apical ring on the hind femora and tibiae, the front and hind tarsi, and the apical four segments on the middle tarsi. There is some variation in amount of the black in some specimens, the Alberta specimen is much paler with only a small preapical spot on the hind femora and some have a dash of black on the inner edge of the front tibiae near the apex and black spots above on the four front femora. The segments of the four front tarsi are expanded on their mesal edges, the basitarsi especially expanded, but not to the extent of those in *granditarsus*, front basitarsi more dilated than the mid-basitarsi. Pubescence of the legs inconspicuous; a few

short blackish bristles at the apices of the tibiae and longer ones on the expanded tips of the four front basitarsi.

Wings tinged with black, darker about the middle, a little longer than the abdomen; squamae and plumule whitish; halteres yellow.

Abdomen gradually broadening to the tip, the apical segments exposed by the median upturning of the fifth tergite; semi-shining black, obscurely yellowish on the extreme edges of the third and fourth tergites, an obscure and irregular median dash of yellowish red on the disc of the third tergite in the Alberta specimen; and a pair of yellowish spots on each of the second, third, and fourth tergites of the Utah specimen; these spots resemble in shape those on *rosarum* Forst. Pile of the abdomen pale, a few black hairs on the fifth tergite. Venter shining brownish black, apices of the sternites yellow.

Types.—Holotype, female, Roggen, Colo., August 31, 1938 (C. L. Fluke); paratypes, two females same data, one female Cooking L., Alta., July 11, 1937 (F. C. Morrison); one female, Pleasant Grove, Utah, August 27, 1938 (G. F. Knowlton). Paratypes in the collections of the University of Alberta, the Utah Agricultural College, and the author.

The Colorado specimens were taken along a sluggish stream in the sand hills about 35 miles East of Greeley. They were collected together with many specimens of *granditarsus*. It will be interesting to note the male whenever it is recognized as the females of the other members of the genus have normal tarsi.

Heliophilus nitidulus, new species

(Fig. 6)

Arista twice the length of antenna, metasternum pubsecent, abdomen shining brassy with a median hour glass shaped opaque area on each of the second and third tergites. Length 11 mm.

Male.—Head black, elliptical; face covered with yellowish to golden colored pubescence, shining black along the sides of the mouth; cheeks with long golden pile; frontal triangle pubescent with only a few short whitish hairs along the orbits, shining just above the antennae, reddish on the upper rim of the antennal pits; ocellar triangle shining black, pile black, occipital pile golden. First two segments of the antennae shining black with black pile, third segment brown, arista long and reddish in color.

Thorax aeneous, the mesonotum somewhat brassy, and with a wide median pollinose vitta; pile golden, intermixed with black hairs which posteriorly are longer than the golden ones, a small patch of black hairs just above the wing base; scutellum shining aeneous with golden pile and longer black pile. Pleura yellowish pollinose and with golden pile, the hypopleura devoid of pile. Metasternum bare, only lightly pollinose. Metathoracic spiracle about as large as the third segment of the antennae.

Legs black, basal one-third of the four front tibiae and their metatarsi reddish; pile of legs all golden except on the hind tibiae and tarsi and the upper sides of the apical segments of the four front tarsi. Hind trochanter with a very small tubercle. Hind femora moderately slender.

Wings cinereous hyaline, the stigma and marginal cells yellowish brown. Squamae, halteres, and plumule yellow to golden.

Abdomen shining with brassy reflections, opaque black on the second and third tergites as follows: fore margins and more broadly the rear margins, each margin connected by a broad median line, giving the areas hour-glass shapes. Venter greyish pruinose. Pile of the abdomen brassy to golden in color, decumbent hairs of the fifth sternite black.

Female.—Very similar to the male. The front is shining aeneous, whitish pollinose at the depression, the pile is sparse and light yellowish. Pile of thorax and abdomen shorter. Shiny spots of second and third tergites not so broad and are placed more forward.

Types.—Holotype, male; allotype, female; and two paratype males, Mexico City, 10,000 ft. elevation, July, 1936 (H. G. Meyer).

I have followed Curran in the designation of the genus; according to Shannon this species would come within the scope of *Xylota*. It is undoubtedly closely related to *Xylota viridaenea* Shannon described from Georgia, but differs principally in the more pollinose front, black pile present on the mesonotum, darker tibiae, and all yellow pile on the fourth tergite.

Criorhina tapeta, new species

(Fig. 7)

Dorsum of the thorax dull black in ground color, the pile all black except around the edges where it is yellowish white; pile of pleura yellowish; fourth tergite and apical corners of third black pilose, elsewhere yellowish pilose; femora enlarged, the hind somewhat arcuate. Length 14 mm.

Male.—Face protruding down and considerably forward, concave below the antennae but very gently convex over the tubercle area; thickly coated with grey polen, the cheeks and lower sides of the face shining black; pile whitish and confined to the lower cheeks, eye margins, and below the antennae on the sides. Frontal triangle black with grey pollen which is black along the median depressed line; ocellar triangle opaque black, the pile black, white behind; pile of the occiput black above and near the eye margins, elsewhere whitish. Anterior ocellus remote. Antennae reddish brown, the first segment darker; arista reddish. Eyes almost touching.

Mesonotum black with dark brown to black pollen, two faint median vittae anteriorly; the pile black but the entire edges fringed with yellowish pile, thus the postalar callosities, the apical half of the scutellum, the sides of the humeri, and from there to the scutellum, yellowish pilose. Pleura with a heavy tuft of yellow pile, which is confined to the posterior half of the mesopleura, the anterior half of the pteropleura,

and the upper part of the sternopleura; rest of the pleura brownish pollinose, short black to brown hairs on the propleura and metapleura. Mesosternum and metasternum yellowish pilose.

Legs black, the tibiae and tarsi reddish brown, apical segments of the tarsi darker; the pile the color of the background. All the femora considerably enlarged, the first and third more than the second pair.

Wing veins broadly clouded, the squamae, halteres, and plumule dark brown.

Abdomen heavily pollinose, grey anteriorly, becoming thinner and darker posteriorly, the fourth tergite with two spots and the apex shining; pile white to reddish on the second and third tergites; black on the first, apical corners of third and all of the fourth tergites; venter with white pile becoming reddish to black on the apex of the fourth sternite. Genital segments mostly yellowish pilose.

Holotype.—Male, Mexico City, 10,000 feet elevation, July, 1936 (H. G. Meyer).

I believe this is a *Criorhina* even though the eyes are almost holoptic. The absence of a mystax, the remote ocellus, the bare face, and the enlarged femora would trace this species to *C. caudatum* Curr. but the size is smaller and the pile of the postalar callosities is yellow. Superficially it resembles the new genus (*Tapetomyia*) described in this paper.

Tapetomyia, new genus

(Figs. 8, 9 and 10)

Bumble-bee like. Face produced below with a small tubercle. Males dichoptic, ocelli equidistant. First joint of antennae shorter than the second, the third only a little longer than the second but broadly truncate; arista basal, loosely plumose, the rays fewer and shorter below. Eyes bare. Thorax thickly pilose, scutellum without ventral fringe. Hind femora straight and slender. Marginal cell open, anterior crossvein ends at the middle of discal cell, oblique, the third vein gently curved into the first posterior cell; apical crossvein recurved to meet the third vein almost at a right angle.

Type of genus *Tapetomyia meyeri* n. sp.

This genus superficially resembles *Criorhina* with its long rostrate face and hairy body but is apparently more closely related to *Arctophila*. It can be told readily by the strikingly truncate antennae and dichoptic eyes of the male. The face is longer and narrower than *Arctophila*.

Tapetomyia meyeri, new species

(Figs. 8 to 10)

Mesonotum thickly black pilose with yellowish white hairs on the sides; the pleura and the scutellum also white haired; pile of the abdomen, reddish, black on the third tergite. Length 14 mm.

Male.—Head shining black with black pile, the front above the depression lightly brownish pollinose; lower slopes of the face thinly pilose and very thinly brownish pollinose, otherwise bare of pile and pollen. Face very long, produced downward and very little forward, with a small rounded tubercle which is situated below the middle; face gently concave above the tubercle; facial grooves prominent, the stripes wide; a narrow pollinose band reaches from the orbits almost to the antennae, broader near the eyes. Front slightly narrowed at the depression; a depressed median streak above the lunule, pit-like anteriorly, but not reaching the depression. Antennae brownish black, the first two segments shining; the third segment truncate; arista basal, black on the basal half, more reddish apically; a little longer than the antennae, 6 to 8 rays above and only 3 or 4 rays below toward the tip.

Mesonotum opaque black, the disc covered with long thick black pile; the outer sides of the humeri, the postalar callosities, the scutellum, the notopleura, the posterior half of the mesopleura, the pteropleura, and the upper half of the sternopleura heavily coated with long white to yellow pile, obscuring the ground color; propleura with black pile; rest of pleura bare. Sternal hairs black.

Legs reddish brown to black, the pile black, more brownish on the tarsi; the femora slender and straight.

Wings with a large brown spot, the posterior apical corner at the juncture of the anterior crossvein and the fourth longitudinal vein, the posterior margin along the fourth vein basally to a point beyond the fork of the second and third veins, and reaching forward to the wing margin; basally from this spot the wing veins yellowish but becoming black at the base. Squamae black; halteres black, the stalk pale colored.

Abdomen oval, shining black with abundant yellowish to reddish pile, black on the third tergite, and basally on the fourth tergite. Ventral pile sparse but long and mostly black. Genital styles long, reddish.

Holotype.—Male, Mexico City, at 10,000 ft. elevation, July, 1936 (H. G. Meyer).

The unusual antennae should make this species easily recognized. It was collected in the mountains near Mexico City by my friend, Prof. Harvey Meyer of the University of Tennessee.

Milesia nigra, new species

(Fig. 11)

A slender dark species, no prominent markings on the thorax, abdomen black beyond the third segment. Length 20 mm., width of abdomen 3 mm.

Male.—Face with the oral margin broadly black, becoming reddish brown and finally yellow beneath the antennae and laterally to the eyes, lower mouth edge and upper tip shining black, otherwise yellowish to brownish pollinose, pile yellow; cheeks reddish yellow, the pile yellow; occiput black with brownish pollen and short yellow pile; frontal triangle mostly obscurely yellow but with a darker band from eye to eye

just above the antennae, yellowish pollinose, pile yellow; ocellar triangle below the median ocellus yellow with yellow pollen and pile, above with dark brown pollen and black pile which becomes yellow behind. Antennae brownish red, hairs on the first two segments black, aristae yellow, the extreme tips black.

Thorax dull black with two narrow golden vittae that are slightly wider anteriorly, the transverse sutures obscurely yellowish pollinose, the humeri and posterior calli reddish, mesonotum narrowly reddish yellow on the sides above the wings and in front of the scutellum, the scutellum shining black with a narrow yellowish apical margin, pile yellow with intermixed black hairs on the disc. Pleura dark, the anterior edge of the mesopleura reddish, the metapleura yellow, pile all yellow. Metasternum with an anterior nose-shaped nodule, pile yellow and black.

Legs reddish, the middle tibiae and tarsi yellow, the hind tarsi black; spur of hind legs yellow. Anterior half of the wings yellowish brown, the spurious vein distinct and darker than the other veins which are yellow. Squamae yellow, the upper lobe darker, edges and fringes dark brown, halteres yellow.

Abdomen shining black, opaque on the disc of the second tergite and basal corners beyond the yellow spots on the third tergite. First tergite yellow; second with three pairs of yellow spots, one on the anterior corners, one near the posterior corners and one median; third with extreme basal corners yellow. Pile black, whitish anteriorly. Venter shining black, pile mostly yellow.

Holotype.—Male, El Volcan, Chiriqui, Republic Panama; February 19, 1936 (W. J. Gertsch). Received through the courtesy of Dr. C. H. Curran.

This species should be easily distinguished from all other American species by its dark color and distinctive markings on the second tergite.

Mallota mystacia, new species

(Fig. 12)

A large species; head and thorax black haired, yellow on the mesosternum and narrowly on the apex of the scutellum; first two abdominal tergites black haired, rest dull yellow pilose. Wings brownish to black the apex and posterior margins almost hyaline. Length 16 mm.

Male.—Eyes widely separated, bare; sides of face brownish grey pollinose, leaving a broad median line and lower face shining black; pile of head all black; a mystax of black hairs present. Face decidedly concave above the tubercle. First two segments of antennae black, the third more brownish; arista long, brownish on the basal third, the apical two-thirds yellow.

Thorax blackish and brownish pollinose, the dorsum with four faint opaque vittae anteriorly, the pile black, yellow on the apical margin of the scutellum and on the mesosternum. Legs black, the tarsi reddish; pile long and black, the short pile on the undersides of the tarsi golden

and the empodial hairs yellow; claws black with yellow bases. Hind femora moderately swollen, but not arched. Wings brownish to black; the costal cell, apex, and posterior margin cinereous hyaline. Squamae, halteres, and plumule black.

Abdomen opaque black; pile of first two tergites black, of the other tergites dull yellow; pile of first two sternites yellow, of the others black.

Holotype.—Male, El Volcan, Chiriqui, Republic of Panama, Feb. 25, 1936. (F. E. Lutz). Received from Dr. C. H. Curran.

At first I thought this might be the male of *nigra* Shannon described from a female from Ecuador but the following notes from the type in the British Museum amply distinguish the two. I wish to thank Mr. John Smart for these notes:

Mallota nigra Shannon

"1. The eyes are covered with sparse hairs.
"2. The hairs on the mesosternum are mixed—both yellow and black.
"3. The tarsi are reddish.
"4. The hair on the first, second, and third sternites is yellow.
"5. The hair on the first, second, and third tergites is black except on the posterior edge of the third tergite where it is yellow."

Lunomyia pollinaria, new species

(Figs. 13 and 14)

A small, yellowish to brownish pollinose species. Face and legs yellow. Length, 7.5 mm.

Female.—Face and cheeks yellow, pollinose, shining on the lower slopes of the face and narrowly around the upper mouth edge and over the tubercle, pile all yellow. Front with parallel sides above, black and covered with brown pollen which is thinner on the edges of the antennal prominence, pile black. Occiput heavily coated with grey to yellowish pollen, pile entirely yellow. Tubercle of face not so prominent as on the genotype *L. cooleyi* Seam. Antennae reddish brown, the first two segments and the upper rim of the third darker; the third segment broader than long, arista reddish.

Thorax yellowish pollinose, the mesonotum with four dark vittae, the median pair narrowly separated and united before reaching the scutellum; pile yellow. Metasternum hairy. Scutellum shining on the disc, pollinose on the edges. Postscutellum pollinose.

Legs yellow with yellow pile, the coxae and trochanters dusky, the apical three segments of the tarsi black; on the upper sides of the tibiae, apically, a dusky spot with the short hairs black; dorsal surface of the hind femora with an elongate black streak. Tiny bristles at base of tibiae, opposite the larger bristles on the hind femora, are black. Apex of hind tibiae rounded.

Wings hyaline, veins yellowish, the stigma very weakly simulating a cross-vein. Squamae and halteres yellow.

Abdomen shining black with a pair of pollinose spots on the second to fourth tergites, edges indistinct, each pair of spots in turn larger than the anterior pair. Margins of the abdomen, apical margin of the fourth

tergite, and all of the fifth, yellowish pollinose. Venter pollinose with yellow pile. Ground color of the margins and apex of the fourth tergite yellow.

Male.—Very similar to the female; facial tubercle less prominent, front narrower with sides diverging posteriorly; pollinose spots absent on second tergite, small on third, but larger on the fourth.

Holotype.—Female, Spooner, Wisconsin, June 16, 1931; allotype, male, Edmonton (Alberta) Canada, June 7, 1918. Allotype in the collection of Dr. R. C. Osburn, Ohio State University, Columbus.

This fly is so distinctively yellowish pollinose and generally light colored that it should never be confused with the other member of the genus which is a dark shining form. The tuberculate face readily places this fly in the genus *Lunomyia* even though it is not so prominent as on the genotype. The face is pollinose and suggests *Lejops*. This species is undoubtedly related to *Helophilus vittatus* Mg. of Europe which may be a true *Lunomyia* as it possesses a tuberculate face.

EXPLANATION OF PLATE I

Fig. 1. Abdomen of male of *Syrphus currani* n. sp. 2. Abdomen of male of *Platycheirus normae* n. sp. 3. Front tibia and tarsus of *Platycheirus normae* n. sp. 4. Front tarsus of *Pyrophaena digitalis* n. sp. 5. Mid-tarsus of *Pyrophaena digitalis* n. sp. 6. Abdomen of male of *Heliophilus nitidulus* n. sp. 7. Head of male of *Criorhina tapeta* n. sp. 8. Head of male of *Tapetomyia meyeri* n. sp. 9. Apex of wing of *Tapetomyia meyeri* n. sp. 10. Femur and tibia of hind leg of *Tapetomyia meyeri* n. sp. 11. Abdomen of male of *Milesia nigra* n. sp. 12. Head of male of *Mallota mystacia* n. sp. 13. Abdomen of male of *Lunomyia pollinaria* n. sp. 14. Head of male of *Lunomyia pollinaria* n. sp.

1 CURRANI

2 NORMAE

3 NORMAE

4 DIGITALIS

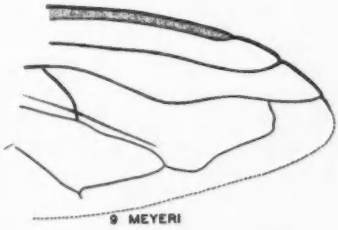
5 DIGITALIS

7 TAPETA

8 MEYERI

8 NITIDULUS

11 NIGRA



9 MEYERI

10 MEYERI

13 POLLINARIA

12 MYSTACIA

14 POLLINARIA

A KEY FOR BLOWFLY LARVAE CONCERNED IN WOUND AND CUTANEOUS MYIASIS

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Outbreaks of the primary screwworm (*Cochliomyia americana* C. and P.) in previously uninfested districts in recent years (Dove and Parman (1935), Dove and Bishopp (1936), King and Bradley (1935), Knipling and Tate (1935), Laake (1935), Robinson (1935)) have created a greater need for a means of recognizing the larvae of *C. americana* and other wound-invading blowflies.

Published records on the incidence of various species of blowflies encountered in wound myiasis (Brennan (1937), Knipling and Rainwater (1937), Laake, Cushing, and Parish (1936)) indicate that the primary screwworm, (*Cochliomyia americana*), is responsible for approximately 90 per cent of the cases in regions infested with that insect. The remaining cases may involve a dozen or more secondary species, principally members of the families Calliphoridae and Sarcophagidae.

A comparative description of all stages of the larvae of *Cochliomyia americana* and *C. macellaria* (F.) is given in the work of Laake, Cushing, and Parish (1936). Descriptions of the larvae of certain species of *Lucilia* are given by Knipling (1936), and characteristics of *Compsomyiops wheeleri* (Hough) have been studied by Deonier and Knipling[1].

The purpose of the present publication is to aid workers in determining larvae implicated in infestations in wounds and cases of cutaneous myiasis[2] in the United States. Blowflies implicated in cutaneous myiasis will also invade wounds. Certain species included in the key, such as *Compsomyiops wheeleri*, *Chloroprocta semiviridis* v. d. W., and certain species of *Lucilia*, have not, to the knowledge of the writer, been reported as being involved in wound or cutaneous myiasis, but, because they have habits similar to those of other secondary blowflies, they are

[1]Deonier, C. C., and E. F. Knipling. Biology of *Compsomyiops wheeleri* (Hough). (Unpublished manuscript.)

[2]Cutaneous myiasis infestations refer to cases of myiasis, primarily in sheep, caused by wool maggots, or fleece worms.

included as possible wound-invading species. This discussion does not, however, include species of the genus *Wohlfahrtia*, the larvae of which penetrate the uninjured skin of animals, producing nodular lesions.

The keys given herein are applicable only to second- and third-instar larvae. A key for differentiating larvae in the first larval instar is not being attempted[3]. Specific differentiating characters for the second-instar larvae of *Lucilia* and the second- and third-instar larvae of *Calliophora*, *Cynomya*, and *Sarcophaga* are not included in the key.

The larva in either the family Calliphoridae or the family Sarcophagidae (fig. 1) is characterized by having prominent fleshy processes or sensory tubercles on the margins of the posterior depression (figs. 2 and 4). Three pairs are present on the upper and generally four pairs are present on the lower margin. The pair on the lower margin that is situated almost within the depressed area is generally small and inconspicuous. The anal protuberance is well developed and possesses a pair of large sensory tubercles. Spines on the segments are well developed and are arranged in bands at the anterior margin, and, in most species, at the posterior margin of some of the segments. The general structure of the cephalopharyngeal mechanism of the larvae may be noted in figures 3 and 5.

The larvae of the family Sarcophagidae, except in the subfamily Sarothromyiinae (Hall 1932), may be distinguished from those of the family Calliphoridae by the presence of a deeper depression of the posterior cavity (fig. 2). The division in the dorsal cornu of the cephalopharyngeal mechanism in Sarcophagidae will also readily differentiate the larvae of Sarcophagidae from those of the Calliphoridae.

Calliphorid larvae are divided into two well-defined morphological groups, as evidenced by the structure of the posterior spiracles in the last larval instar (figs. 11 and 12) and by the structure of the oral hooks in the second larval instar (figs. 6 and 7). One of these groups, the members of which are closely allied, includes the genera *Cochliomyia*, *Phormia*, *Protophormia*, *Compsomyiops*, and *Chloroprocta;* the other group is composed of the genera *Lucilia*, *Calliphora*, and *Cynomya*. Generally speaking, generic differences are readily apparent in the larvae, and in

[3]For specific characters of the first instar of the primary screwworm (*Cochliomyia americana*) consult Laake, Cushing, and Parish (1936).

many instances specific characters can be established, although in some cases this is difficult in the closely allied species of *Lucilia* and *Calliphora*.

In choosing diagnostic characters the writer has employed external characters wherever possible. In some cases, however, particularly for the second-instar larvae, he has used internal characters, and mounted or dissected specimens will be needed for their examination.

KEY TO LARVAL INSTARS

1. Anterior spiracles absent; posterior spiracles not provided with a peritreme; the two spiracular openings or slits of each posterior spiracle contiguous at the lower ends..... **First larval instar**

   Anterior spiracles present; posterior spiracles provided with a peritreme; spiracular slits distinctly separated..... 2

2. Posterior spiracles each with two spiracular slits..... **Second larval instar**

   Posterior spiracles each with three spiracular slits..... **Third larval instar**

KEY TO SECOND-INSTAR LARVAE

1. Last apparent segment with a deep posterior cavity (fig. 2); dorsal cornu of the cephalopharyngeal sclerites incised (fig. 3)..... **Sarcophagidae**[4]

   Last apparent segment not deeply depressed (fig. 4); dorsal cornu not incised (fig. 5)..... 2

2. Oral hooks tapering to a point (fig. 6)..... 3

   Oral hooks enlarged near tips (figs. 7 and 8)..... 8

3. Main tracheal trunks pigmented, the pigmented portion extending anteriorly two-thirds the length of segment 12 (fig. 9), (primary screwworm..... **Cochliomyia americana** Cushing and Patton

   Main tracheal trunks not pigmented (fig. 10)..... 4

4. Dorsal spines present on posterior margin of segment 11..... 5

   Dorsal spines absent on posterior margin of segment 11..... 6

5. Dorsal spines absent on posterior margin of segment 10, **Phormia regina** (Meigen)

   Dorsal spines present on posterior margin of segment 10, **Protophormia terrae-novae** (Robineau-Desvoidy)

6. Spines on anal protuberance arranged as in figure 15, **Chloroprocta semiviridis** Van der Wulp

   Spines on anal protuberance arranged in a V-shaped group (fig. 16)..... 7

7. Ratio of distance between inner tubercles on upper margin of posterior cavity and distance between inner and median on each side approximately 1.5 : 1..... **Cochliomyia macellaria** (Fabricius)

   Ratio of distance between tubercles mentioned above approximately 1.1 : 1, **Compsomyiops wheeleri** (Hough)

8. Oral hooks as in figure 7..... **Lucilia**

   Oral hooks as in figure 8..... **Calliphora, Cynomya**

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[4]At least six species of Sarcophagidae, all members of the genus *Sarcophaga*, are known to occur in wounds of animals.

KEY TO THIRD-INSTAR LARVAE

1. Last apparent segment with a deep posterior cavity (fig. 2); dorsal cornu of the cephalopharyngeal sclerites incised (fig. 3)..... **Sarcophagidae**

   Last apparent segment not deeply depressed (fig. 4); dorsal cornu not incised (fig. 5)..... **Calliphoridae,** 2

2. Posterior spiracles with an incomplete ring or peritreme; "button" poorly defined (fig. 11)..... 3

   Posterior spiracles with a complete peritreme; "button" distinct (fig. 12).... 8

3. Main tracheal trunks leading from posterior spiracles dark brown to black (fig. 13), (Primary screwworm),
   Cochliomyia americana Cushing and Patton

   Tracheal trunks leading from posterior spiracles not pigmented (fig. 14).... 4

4. Posterior margin of segment 11 without dorsal spines..... 5

   Posterior margin of segment 11 with dorsal spines..... 7

5. Spines on anal protuberance arranged as in figure 15; dorsal spines absent on segments 8 to 10..... **Chloroprocta semiviridis** Van der Wulp

   Spines on anal protuberance arranged in a V-shaped group (fig. 16); dorsal spines present on segments 8 to 10..... 6

6. Accessory oral sclerite absent (fig. 17)..... **Cochliomyia macellaria** (Fabricius)

   Accessory oral sclerite present (fig. 18)..... **Compomyiops wheeleri** (Hough)

7. Length of larger tubercles on upper margin of posterior cavity distinctly more than one-half width of one posterior spiracle; dorsal spines present on posterior margin of segment 10,
   Protophormia terrae-novae (Robineau-Desvoidy)

   Length of larger tubercles on upper margin of posterior cavity less than one-half width of one posterior spiracle; dorsal spines absent on posterior margin of segment 10..... **Phormia regina** (Meigen)

8. Accessory oral sclerite absent, as in figure 17..... **Lucilia,** 9

   Accessory oral sclerite present, as in figure 18..... **Calliphora, Cynomya**

9. Dorsal spines absent from posterior margin of segment 11,
   Lucilia eximia (Wiedemann)

   Dorsal spines present on posterior margin of segment 11..... 10

10. Inner tubercles on upper margin of posterior cavity separated by a distance approximately equal to distance from inner to median tubercles on each side..... **Lucilia sericata** (Meigen)

    Inner tubercles on upper margin of posterior cavity separated by a distance approximately equal to distance from inner to outer tubercles on each side..... 11

11. Peritreme between outer (lower) and median spiracular slits not projecting inward (fig. 19); 3 to 4 irregular rows of spines on dorsum and at posterior margin of segment 11..... **Lucilia cuprina** (Wiedemann)

    Peritreme between outer and median spiracular slits projecting inward (fig. 12); 6 to 8 irregular rows of dorsal spines at posterior margin of segment 11..... 12

12. Floor of pharynx at the posterior end of ventral cornu pigmented (fig. 20),
    Lucilia illustris (Meigen)

    Floor of pharynx not pigmented as above..... 13

13. Dorsum of segment 12 scabrous; dorso-lateral surface of segment 11 with 1 to 2 irregular rows of spines situated near anterior margin of segment,
    Lucilia silvarum (Meigen)

    Anterior half of segment 12 smooth on dorsum; dorso-lateral surface of segment 11 devoid of spines,
    Lucilia caeruleiviridis Macquart, **Lucilia mexicana** Macquart

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EXPLANATION OF FIGURES

PLATE I

Fig. 1. Lateral view of a blowfly larva. 1, First apparent or cephalic segment; *oh*, oral hooks; *asp*, anterior spiracle; *spa*, spines at anterior margin of segment; *spp*, spines at posterior margin of segment; 12, last apparent or twelfth segment; *t*, sensory tubercles on upper margin of posterior cavity; *pc*, posterior cavity; *ap*, anal protuberance; *at*, anal tubercle.

Fig. 2. Caudal aspect of last apparent segment of a sarcophagid larva (third instar): *ps*, Posterior spiracle; *i*, *m*, *o*, inner, median, and outer tubercles, respectively, on upper and lower margins of posterior cavity; *pc*, posterior cavity; *ap*, anal protuberance; *at*, anal tubercle; *a*, anal opening.

Fig. 3. Lateral view of cephalopharyngeal mechanism of a sarcophagid larva (third instar): *oh*, Oral hook; *phs*, pharyngeal sclerite; *dc*, dorsal cornu; *vc*, ventral cornu; *ph*, floor of pharynx.

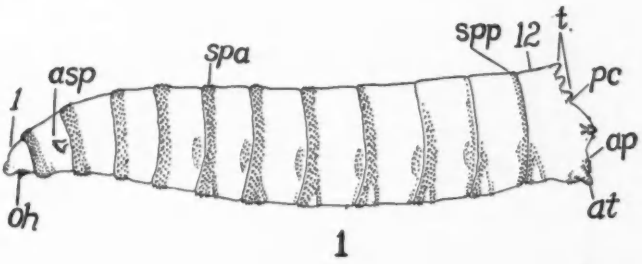
Fig. 4. Caudal aspect of last apparent segment of a calliphorid larva (third instar).

Fig. 5. Lateral view of cephalopharyngeal mechanism of a calliphorid larva (third instar).

Fig. 6. Cephalopharyngeal mechanism of a second-instar larva, showing the appearance of the oral hooks in such genera as *Cochliomyia*, *Phormia*, *Protophormia*, *Compsomyiops*, and *Chloroprocta*.

Fig. 7. Cephalopharyngeal mechanism of a second-instar larva of *Lucilia*.

Fig. 8. Cephalopharyngeal mechanism of a second-instar larva of *Calliphora* or *Cynomya*.



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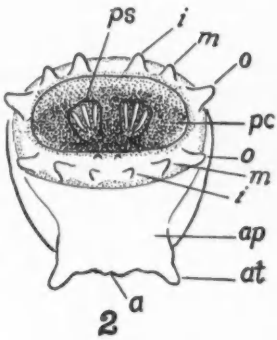

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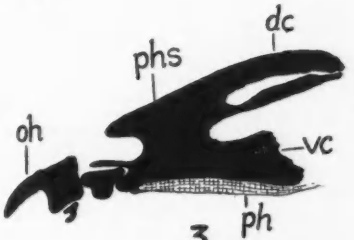

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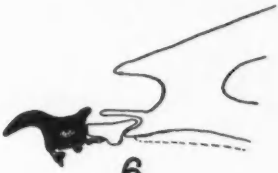

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PLATE II

Fig. 9. Posterior segments of second-instar larva of *Cochliomyia americana*, showing pigmented portion of main tracheal trunks. (Lateral aspect of a cleared larva.)

Fig. 10. Posterior segments of a second-instar blowfly larva other than *Cochliomyia americana*, showing difference in pigmentation of tracheal trunks.

Fig. 11. Posterior spiracular plate of a third-instar blowfly larva, showing general appearance in the genera *Cochliomyia*, *Phormia*, *Protophormia*, *Compsomyiops*, and *Chloroprocta*: *p*, Peritreme; *sps*, spiracular slits; *b*, button.

Fig. 12. Posterior spiracular plate of a third-instar blowfly larva, showing general appearance in the genera *Lucilia*, *Calliphora*, and *Cynomya*.

Fig. 13. Dorsal view of posterior segments of third-instar larva of *Cochliomyia americana*, showing pigmented tracheal trunks.

Fig. 14. Dorsal view of posterior segments of a blowfly larva, showing absence of pigmentation in tracheal trunks of species other than *Cochliomyia americana*.

Fig. 15. Anal protuberance of larva of *Chloroprocta semiviridis*, showing arrangement of spines (caudal aspect).

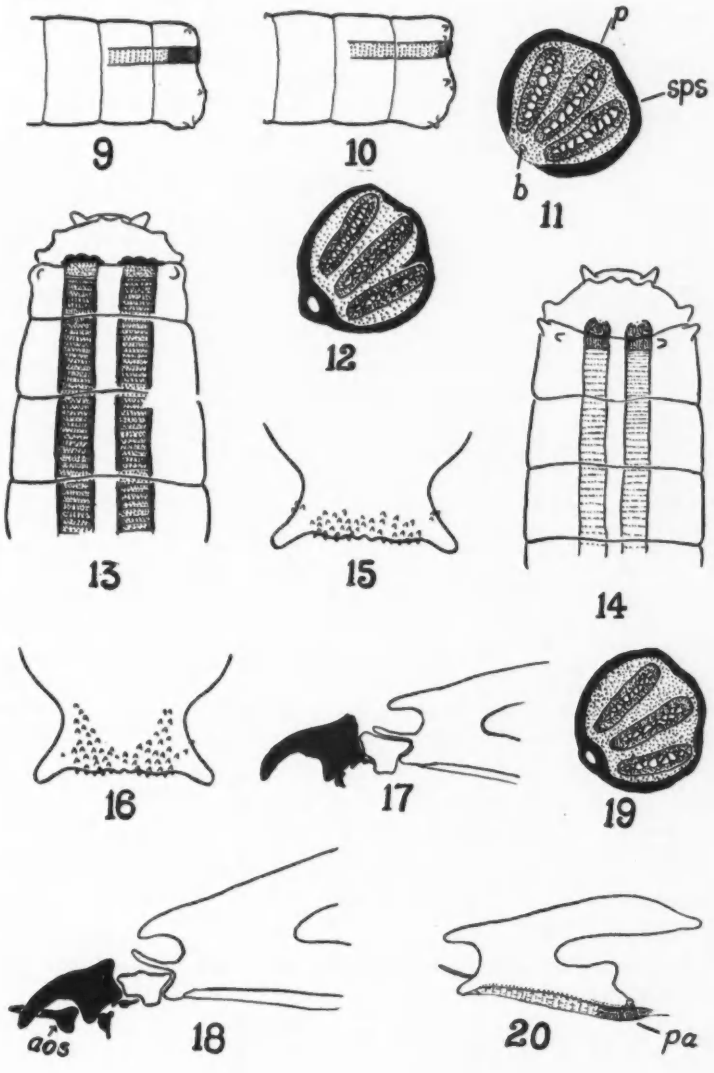
Fig. 16. Anal protuberance of a larva of *Cochliomyia macellaria* or *Compsomyiops wheeleri*, showing arrangement of spines (caudal aspect).

Fig. 17. Oral hooks of third-instar larva of *Cochliomyia macellaria*, showing absence of the accessory oral sclerite.

Fig. 18. Oral hooks of third-instar larva of *Compsomyiops wheeleri*, showing presence of accessory oral sclerite *aos*.

Fig. 19. Posterior spiracular plate of third-instar larva of *Lucilia cuprina*, showing absence of an inward projection of peritreme between outer and median spiracular slits.

Fig. 20. Pharyngeal sclerite of larva of *Lucilia illustris*, showing a slight pigmentation of a portion of the pharynx (*pa*, pigmented area of the pharynx).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A NEW GENUS AND SEVERAL NEW SPECIES OF NORTH AMERICAN HISTERIDAE (COLEOPTERA)

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Chicago, Ill.

The following *Histeridae* are described chiefly from the collections of the U. S. National Museum and the U. S. Biological Survey. The writer is indebted to Dr. Edward A. Chapin, Mr. Herbert S. Barber, and Mr. Lawrence W. Saylor for their kind co-operation in making the material available for study.

Subfamily **Abraeinae**

Acritus attaphilus n. sp.

Color dark reddish brown, surface rather strongly shining. Form oval, strongly convex. Head sparsely, minutely punctate, without striae.

Pronotum a little more than twice as broad as median length, sides strongly converging, nearly straight on basal half, thence strongly arcuate to apical angles which are acute. Basal angles acute and slightly produced posteriorly. Basal margin obtusely angulate (angle about 135 degrees). Surface minutely, sparsely punctate, one or two rows of punctures along the basal margin sensibly coarser and more strongly impressed.

Scutellum small. Elytra together slightly broader than long and distinctly broader than pronotum, their sides evenly arcuate from base to apex, their apices transversely truncated. Punctation of elytra basally similar to that of pronotal disc, the punctures gradually becoming very slightly coarser and more strongly impressed apically. Flanks very sparsely, extremely minutely punctate. Marginal stria very finely cariniform, extending from base to apical angle. Discs of elytra sometimes with one to three feebly impressed rudiments of striae on lateral halves.

Propygidial punctation similar to that of pronotal disc; pygidial punctation the same basally, the punctures becoming slightly coarser and more closely placed at apex. Surface of pygidium finely, transversely alutaceous, and sometimes with an extremely fine, apical marginal stria (this, when present, visible only under extremely high magnification).

Prosternal keel narrow (in comparison to other *Acritus*), about a third broader at base than at apex, anterior margin slightly truncated, basal margin very feebly, broadly emarginate. Carinal striae strongly divergent on basal half, subparallel on anterior half of prosternum. Lateral prosternal striae diverging anteriorly and joining, on each side, the finely beaded anterior margin of the prosternum.

Anterior mesosternal margin obtusely, outwardly angulate. Marginal mesosternal stria fine, continuous with the marginal metasternal stria. Meso-metasternal suture not represented by a stria or a row of punctures, but by a narrow smooth space. Meso- and metasternum minutely, sparsely punctate, the punctures becoming very slightly coarser apically on the metasternum.

Outer margin of anterior tibiae evenly arcuate and finely spinulose to near apical fourth, thence obliquely, strongly convergent to apex. Inner margin distinctly, inwardly arcuate. Middle and posterior tibiae widest at their apices, their outer margins finely spinulose. Tarsi of the anterior and middle legs 5-jointed, those of the posterior tarsi 4-jointed.

Length:[1] 1.25–1.37 mm. Width: .80–.89 mm.

Holotype: A male (No. 53076, Coll. U. S. Nat. Mus.).

Allotype: A female (No. 53076, Coll. U. S. Nat. Mus.).

Paratypes: 35 specimens, 25 of which are deposited in the collection of the U. S. Nat. Museum; the balance are in the collection of the writer.

Type data: All the specimens were collected by E. V. Walter, 10 feet down in a nest of *Atta texana*, at Boerne, Texas, March 3, 1935.

From the other known North American species of *Acritus* belonging to the group without a transverse basal row of submarginal pronotal punctures, *attaphilus* may easily be distinguished by its larger size, prosternal characters, and surface sculpture.

Subfamily **Saprininae**

In the spring of 1897, H. G. Hubbard made a brief investigation of the insects found in the burrows of the kangaroo rat (*Dipodomys desertorum*) and an unidentified desert spermophile. A report of this study was published in the same year (as one of Hubbard's "Letters from the Southwest"). In this paper three species of *Histeridae* were reported, two of them as belonging to new genera allied to *Chelyoxenus* and one as a new species of *Saprinus*. The writer has received this material on loan from the U. S. National Museum collection, and study of the specimens shows one of these to be *Saprinus* (*Eremosaprinus*) *unguiculatus* Ross, the second, a new species of *Eremosaprinus* (described below) and the third, *Saprinus suffusus* Csy. The unique type of the latter species was undoubtedly from Hub-

[1]All measurements of length included in this paper were made from the anterior pronotal angles to the tip of the pygidium.

bard's series (the data and labels are identical) although Casey made no acknowledgment of the source.

Saprinus (Eremosaprinus) unguiculatus Ross (1939, p. 40)[2]

Two specimens, a male and female from the burrows of *Dipodomys desertorum*, were collected by H. G. Hubbard, March 22, 1897, at Palm Springs, California. The original description of this species is very adequate. It might be well to add, however, that in the two specimens at hand the elytra show a distinct trace of brownish maculations.

The following species is named in honor of the collector.

Saprinus (Eremosaprinus) hubbardi n. sp.

Color black, excepting a yellowish red maculation on each elytron, this maculation separated from basal, sutural and apical margins by a rather broad area and extending laterally to the first dorsal stria. Surface rather feebly shining. Head finely, shallowly, rugosely punctate, ground surface finely alutaceous, subopaque.

Pronotum about twice as broad as long; sides nearly straight, strongly converging; apical angles evenly rounded; anterior margin broadly, arcuately emarginate; basal margin obtusely angulate. Marginal stria distinct on each side and around the anterior angles, absent behind the head. Disc distinctly alutaceous and finely, remotely, sparsely punctate, excepting a smooth, roughly triangular, antescutellar area. A lateral area on each side is rather feebly rugoso-punctate, subopaque. Basal edge with a few fine, submarginal punctures and a distinct submarginal antescutellar impression.

Elytra together, a little more than one-third broader than long, a little more than twice as long as, and at humeri distinctly broader than, the pronotum. Surface remotely, sparsely punctulate, and finely, feebly, alutaceous. Marginal elytral stria very finely cariniform, extending from base around apical angle, from thence obsolete. External subhumeral stria very short, basal, distinct from the marginal; internal subhumeral stria extending from basal sixth to apical sixth; humeral stria finely impressed and nearly parallel to the first dorsal. First dorsal stria extending to about apical sixth (from basal fourth on one side and basal seventh on the other side, in the type.) Both the internal subhumeral and first dorsal striae are simply finely impressed basally, their apical portions being finely cariniform. Basally and approximate to the humeral and first dorsal striae are several short finely impressed lines. Basally and medially on each elytron is a vague impression which may represent either the second or third dorsal stria; the remaining dorsal striae are absent. Sutural stria finely impressed, extending from a little beyond the middle to apex and around apical angle, from thence obsolete.

[2]The paper in which this species was described was still awaiting publication at the time this paper was written; however, Mr. Ross kindly sent a copy of his manuscript and thus made the description known to the writer.

Propygidium and pygidium alutaceous. Propygidium almost impunctate basally, and rather finely, densely punctate, apically and laterally. Pygidium slightly more coarsely punctate, the punctures a little more widely separated, excepting at apex where they are nearly contiguous. Apex slightly flattened.

Hypomera fimbriate. Prosternal sides rather abruptly declivous; keel rather broad, nearly flat and margined on each side by a very fine stria which extends from near the base to apex. Prosternum sensibly wider at middle than in the region of the coxae and the antennal fossae, its apex distinctly, narrowly, emarginate.

Marginal mesosternal stria fine, subcariniform, lateral, absent along anterior margin. Meso-metasternal stria extremely fine. Meso- and metasternum remotely punctate, microscopically alutaceous.

Anterior tibiae each with eight to nine small teeth, the apical teeth distinctly longer. Outer edges of middle and posterior tibiae with a marginal row of long spinules and a row of submarginal, shorter spinules. Tarsi of all the legs bearing bristles dorsally and ventrally, the ventral bristles long. Ultimate joint of all the tarsi bearing two long claws which are fused so as to appear as a single claw.

Length: 4.17 mm. Width: 3.51 mm.

Type: A unique female, same data as the preceding species, in the collection of the U. S. Nat. Mus. (No. 53077).

This species may be easily separated from the other species of the subgenus *Eremosaprinus* by its distinctly maculate elytra, its reduction of dorsal striae, and the prosternal emargination. It is related to *S. unguiculatus* by virtue of its fused tarsal claws, but in addition to the diagnostic characters given above it differs in having the median portion of the pronotal disc, the elytra, and the discs of the pro-, meso-, and metasternum so sparsely and very finely punctate as to appear nearly smooth. The elytral striae present are finer than in *unguiculatus*. Its entire surface is very finely, shallowly, alutaceous, excepting an antescutellar pronotal area and a common elytral area along the suture.

The writer believes that *S. hubbardi* and *S. unguiculatus* should be retained in *Eremosaprinus*, this latter category to be considered as of generic standing, while the other species originally included by Ross should be placed in a new subgenus, this to be considered as a connecting link between *Eremosaprinus* and an ancestral stock related to group II of Horn's classification (1873). Such an opinion is necessarily subjective; it does not matter, really, what ranking these categories are given as long as the apparent phylogenetic relationships are borne in mind.

The writer takes pleasure in naming the following species after Mr. Edward S. Ross, also a student of the Histeridae, whose courtesies and co-operation have proved very valuable.

Saprinus rossi n. sp.

Color black, feebly shining. Form oval, convex. Head strongly, not coarsely punctate, the punctures finer and closer on the epistoma. Supraorbital stria fine, complete.

Pronotum nearly twice as broad as long, sides nearly straight, rather strongly converging to apical angles, the latter broadly, evenly rounded; pronotal emargination not very deep; basal margin obtusely angulate. Marginal stria complete, well impressed. Discal punctation in a rather narrow median area similar to that of vertex of head, the punctation becoming coarser and subcribrate laterally, with sparse fine punctures intermingled. Basal margin with several rows of close punctures.

Elytra together about six-sevenths as long as broad, at humeri sensibly broader than the pronotum, sides feebly arcuate and slightly converging apically. Marginal epipleural stria a fine costa. Marginal elytral stria extending from base around apical angle to suture, the stria being a fine costa laterally and finely impressed from apical angle to suture. External subhumeral short, basal, distinct from, and parallel to, the marginal elytral stria; internal subhumeral stria punctate, present on middle third; oblique humeral stria punctate, not well impressed, parallel to the first dorsal stria, not joined to the internal subhumeral. Dorsal striae one to four subequal, punctate, extending to about the middle, fourth dorsal stria arched at base; sutural stria absent. Discs of elytra coarsely, strongly punctate, the punctures separated by a little less than their diameters in the scutellar region, elsewhere more closely placed and subcribrate, with fine, strong punctures intermingled. In a very narrow area along the suture (ordinarily the interval between the suture and the sutural stria) the punctures are fine and sparse. Elytral flanks finely, not sparsely, punctate.

Propygidium finely, densely punctate. Pygidium a little more coarsely punctate basally, the punctures becoming dense and finer apically; disc bi-impressed near apex, the impressions small, elongate, rather widely separated and not very well defined; sides with a marginal stria on apical half, the stria uninterrupted and sulciform at apex.

Prosternum strongly convex, deeply, finely, sparsely punctate and finely alutaceous. Prosternal striae anteriorly divergent and ascending, and becoming coarser to terminate in rather large, deep, crescent-shaped foveae from which a transverse linear portion descends to prosternal keel, the linear portions not joining, separated by the width of the keel.

Mesosternum with a very fine, subcariniform, marginal stria which is continuous with that of the metasternum. Meso-metasternal stria represented by a row of coarse punctures. Meso- and metasternum coarsely, sparsely punctate. First sternite with a nearly smooth, median space, lateral to which the punctures are coarse on basal half and abruptly fine on apical half.

Anterior tibiae five to six denticulate, the teeth spine-like and not very long. Middle tibiae biseriately spinulose, posterior tibiae uniseriately spinulose.

Length: 2.98 mm. Width: 2.28 mm.

Type: A unique female, collected on dog carrion by the writer at Camp Fort Dearborn near Schiller Park, Ill., June 8, 1935.

This species may easily be distinguished from *S. aequipunctatus*, a California species to which it appears to be most closely allied, by the character and disposition of its elytral striae, its coarser, less even punctation, and its very different pygidial characters. The striae in *rossi* are poorly defined because of the fact that the strial punctures are not very distinct from the discal punctures, while in *aequipunctatus* the striae, though punctate, are well defined. *S. rossi* is also shorter and more oval than the subparallel *aequipunctatus*.

Subfamily **Histerinae**

The following species, apparently unknown since the time of its description, is redescribed from three examples in the collection of the U. S. Biological Survey.

Hister tornatus LeC. (1880, p. 190)

Color black, strongly shining. Form elongate, oblong subparallel, stoutly subcylindrical. Antennal club oval, apparently 3-jointed. Mandibles stout, longitudinally concave above, each with a median tooth. Labrum short, transverse, somewhat compressed antero-posteriorly. Head finely, rather closely punctate. Supraorbital stria absent. Frontal stria complete, subcariniform.

Pronotum a little broader than long (7.6 : 6.6), sides evenly arcuate, not strongly convergent anteriorly; anterior angles rather acute, basal margin strongly arcuate. Marginal stria distinct, interrupted behind the head. Inner lateral pronotal stria subcariniform, complete, sinuate basally, deeply impressed and approaching the margin near the anterior angles and behind the head. Outer lateral stria close to the margin, subcariniform, extending from about apical fifth to basal fifth. Disc sparsely, very finely, punctate throughout.

Elytra together about as broad as long, at the humeri slightly broader than the pronotum, finely sparsely punctate throughout. Marginal elytral stria punctiform, present from basal two-fifths to apical angles and possessing a short basal appendix. Epipleurae with one other stria than the marginal, this close to and lateral to the marginal elytral stria on apical half. Marginal epipleural stria also present. Subhumeral stria absent; oblique humeral stria finely impressed. First dorsal stria abbreviated at apical fifth and near base, the basal portion very finely impressed; second dorsal stria complete, finely impressed on

basal two thirds, from thence to apex so finely impressed as to be nearly indiscernible; third dorsal stria finely impressed from base to a little beyond middle, nearly indiscernible from thence to apex; fourth, fifth, and sutural striae, extremely fine, nearly untraceable, fourth somewhat abbreviated at base and extending to near apex, the fifth arching at base and joining the sutural.

Propygidium finely, sparsely punctate, the punctures becoming coarser basally and laterally, with minute punctures intermingled; pygidium similarly punctate.

Prosternum convex, keel non-striate, with a few punctures anteriorly on each side near the lateral marginal stria. Prosternal lobe rounded, marginal stria deeply impressed, complete; outside the marginal stria, on each side of the lobe, is an additional short stria; lobe rather closely, deeply, not coarsely punctate.

Mesosternum not emarginate, sparsely punctulate, with a deeply impressed marginal stria and a rather short, transverse stria on each side between the marginal stria and the antero-lateral angles. Metasternum remotely punctulate.

Anterior tibiae four-dentate, with an indication of a fifth tooth basally, the apical tooth larger than the others and feebly bifid. Middle and posterior tibiae biseriately spinulose.

Length: 4.63–4.83 mm. Width: 2.52–2.9 mm.

Data: Two examples taken by A. A. Wright from the stomach contents of *Bufo terrestris*, Okefinokee Swamp, Ga., in the summer of 1912; one example collected by E. R. Kalmback at Myrtle Beach, Harvey Co., S. C., April 22, 1919.

This very distinct species can be easily recognized because of its stoutly subcylindrical form, its non-emarginate mesosternum, the character of the anterior tibiae, and the peculiar striation of the elytra. The dorsal elytral striae, excepting those striae, or portions of striae, specifically described as *very* finely impressed (not those portions described only as finely impressed) are almost indiscernible, excepting in certain lights. The extent of the better impressed portions is a little at variance in the three specimens at hand. The frontal stria and the lateral pronotal striae are described as subcariniform. By this the writer means that the outer edges of these striae are feebly carinate while the inner margins are indistinct. The frontal stria in *tornatus* resembles that of *H. carinifrons* Schffr. By reason of its truncate mesosternum *tornatus* should be placed in the subgenus *Atholus*, but there is no other character by which to relate it to the species of this subgenus. While this species cannot be placed in any of the groups of *Hister* known to the writer, nevertheless it seems unwise to erect a new subgenus for it, because the classification of the genus *Hister* into sub-

genera and groups is at present rather chaotic and requires extensive revision.

Subfamily **Hetaeriinae**

Tribe **Hetaeriomorphini**

Yarmister n. gen.

Form elongate, oblong subparallel, rather strongly convex. Antennae 9-jointed, inserted under the margin of the front; scape broadly expanded, somewhat compressed; funicle articulated laterally to the scape; club oval, consisting of a "single" joint, clothed with dense pubescence. Epistoma elevated above the labrum, though not nearly as decliviously nor as distinctly as in *Homalopygus*. Head with marginal, frontal, and supraorbital striae. Mandibles stout. Pronotum emarginate anteriorly, and possessing a single lateral stria. Scutellum small. Elytra with dorsal striae. Propygidium about three-fourths as long as broad, hexagonal. Pygidium barely visible from above.

Prosternum moderately compressed, keel striate. Prosternal lobe broad, separated from the prosternum by a fine transverse suture. Antennal cavities deep, in the anterior angles of the prothorax, closed, visible from beneath. Mesosternum rather narrow, deeply emarginate anteriorly for the reception of the basal portion of the prosternum. Anterior femora broadly elongate, flat. Middle and posterior femora convex, subcircular. All the tibiae strongly expanded, compressed, their outer margin armed with numerous small spinules or fine denticles. Anterior tibiae subcircular, tarsal groove sinuate, parallel to the outer margin of the tibia, only the inner margin of the groove well defined. Middle tibiae very feebly triangular, tarsal groove straight, oblique. Posterior tibiae subtriangular, apices broadly truncate, tarsal groove nearly praallel to apical margin.

Type of the genus: Yarmister barberi n. sp., which I name after Mr. H. S. Barber.

The type, upon which the description of this genus is based, was labelled *Homalopygus* in the U. S. National Museum Collection. *Yarmister* differs markedly from *Homalopygus* in the manner in which the epistoma is elevated above the labrum, the structure of the sterna, the very long propygidium, and the character of the tibiae which closely approach those of *Discoscelis* Schmidt. The anterior margin of the epistoma in *Homalopygus* is inwardly declivous and markedly elevated above the labrum. In *Yarmister* the anterior margin is vertical and only slightly elevated above the labrum. The genus should not be placed near *Homalopygus;* it differs rather strikingly from any of the described genera and consequently is difficult to place.

Yarmister barberi n. sp.

(Figures 1–6)

Form rather narrowly oblong, subparallel, strongly convex. Color black, shining. Surface remotely punctulate throughout. Antennal scape angulate, expanded, rather compressed, its upper surface finely margined on each side and with an additional fine stria parallal to the median margin. Vertex of head shallowly impressed. Supraorbital stria fine, complete; frontal stria fine, subcariniform, continuous with the supraorbital and separating the front from the clypeus; marginal stria fine, subcariniform, extending from the eye around the clypeus.

Pronotum about one-third broader than medium length; sides subparallel, nearly straight basally and feebly converging anteriorly almost to apex, from thence strongly convergent to anterior angles; basal margin broadly arcuate. Marginal stria absent laterally, present on each side around the anterior angles, broadly interrupted behind the head. Lateral pronotal stria rather close to the margin, continuous around the anterior angles and complete behind the head; interval between the margin and the lateral pronotal stria convex.

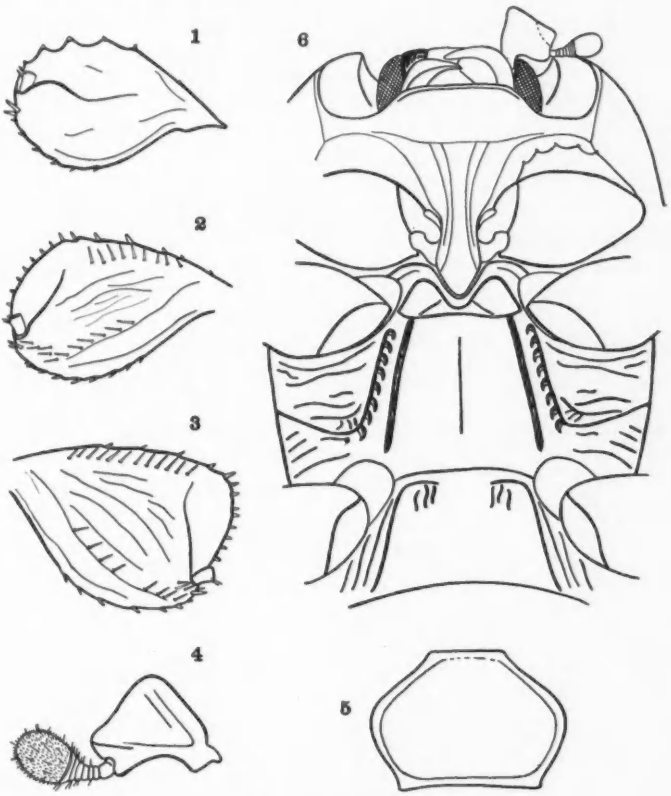
Elytria together about as broad as long, at humeri not broader than pronotum; sides subparallel, slightly sinuous at middle; apices obliquely subtruncate. Marginal stria sinuous, subcariniform, extending from base to apex. External subhumeral stria straight, subcariniform, complete. Internal subhumeral and oblique humeral striae absent. Dorsal striae one to three present, coarsely subcariniform, extending to apical margin and thence medially hooked, the third stria slightly abbreviated basally. Sutural stria complete and arcuately arching outwards both at base and apex.

Fifth abdominal tergite exposed between the elytral apices and possessing two parallel, chevron-shaped striae. Propygidium distinctly margined, excepting along the basal, transverse edge.

Prosternum narrowest at middle. Carinal striae extending from anterior suture (suture between prosternum and prosternal lobe) to base, the striae subparallel at middle and divergent basally and apically. Interval between the carinal striae flat basally, slightly convex apically. Lateral striae present on apical half of prosternum just lateral and parallel to the carinal striae. Prosternal lobe broadly truncated at apex, its marginal stria well impressed, present only along the truncated anterior margin, absent laterally.

Mesosternum deeply emarginate at the middle of the anterior margin, marginal stria deeply impressed, complete. Meso-metasternal stria doubled, the posterior stria complete and transverse, the anterior stria bipartite and on each side extending medially and antero-obliquely from the posterior stria towards the mesosternal sinus. Metasternum doubly margined, the striae very coarse, almost sulcus-like, neither stria joining the marginal mesosternal stria although the inner of the two unites with the posterior portion of the meso-metasternal stria; the outer of these two striae is very deeply, coarsely punctate. Laterally the meso- and metathoracic sternites and pleurites possess a number of groove-like, parallel striae. The first abdominal sternite is margined baso-laterally and possesses a few short groove-like striolae on each side near its basal margin.

Anterior tibiae with five to six fine denticles on the outer edge and a few fine spinules along the inner margin. Apical spurs small. Middle and posterior tibiae uniseriately spinulose along external, apical and internal margins, the spinules of the outer margins a little stouter and less acute than those of the inner.



Yarmister barberi n. gen. n. sp.

Fig. 1, right anterior tibia. Fig. 2, left middle tibia. Fig. 3, right posterior tibia. Fig. 4, left antenna. Fig. 5, propygidium. Fig. 6, ventral view showing structure of pro-, meso-, and metasternum.

Type: An example of undetermined sex, collected by Mr. Herbert S. Barber at Paradise Key, Fla., March 2, 1919 (No. 53078, U. S. National Museum Collection) by beating in a dense subtropical hammock.

Paratype: One example, of undetermined sex, labelled "Fla." and "*Hister tornatus*" from the C. W. Leng collection of Histeridae, which is now in the possession of Mr. E. S. Ross.

The recording of this new genus and species of the tribe *Hetaeriomorphini* from Florida is not too surprising since the type locality is decidedly neotropical in many respects and has been poorly collected. Although the type was collected by beating, the species will probably be found to be either myrmecophilous or termitophilous, as are nearly all the members of the tribe as far as is known. It is interesting to note that this species conforms rather well in most respects to a drawing made of an undescribed adult termitophilous Histerid by Dr. Alfred E. Emerson. This latter species was collected by Dr. Emerson in British Guiana in the nests of *Kalotermes*. It is very possible that the two are congeneric.

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Hubbard, H. G. 1897. Letters from the southwest (Insect fauna in the burrows of desert rodents). Proc. Ent. Soc. Wash. 4: 361–364.

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LES INSECTES FOSSILES DES TERRAINS OLIGOCENES DE FRANCE by NICOLAS THEOBALD. Pp. 1–473, 17 text figs., 7 maps, 13 tables, 29 plates. (Mem. Soc. Sci. de Nancy, 1937.) Price not given.

We wish to call the attention of those entomologists interested in fossil insects to this elaborate volume on the fossil insects of the Oligocene age in France. The "Premiere Partie" is a series of six chapters (104 pp.) on the geology of the areas covered. The "Deuxieme Partie" (pp. 105–446) of eight chapters deals with the hundreds of fossil insects which have been found in these strata. Each of the eight chapters is devoted to the fossil insects of a unit region. A total of about 190 genera are represented. We can judge only the descriptions and figures in our own group, the Odonata. We feel certain that the fossils of this group will have to be restudied by students familiar with modern Odonata. They should be refigured very carefully in line drawing after very exacting study.

Broad studies of this kind give the scientific world a general idea of the fauna reviewed but before any of the material can be incorporated into the philogenetic system of a major group it has to be restudied by some one with more time and a thorough knowledge of the group being worked over.—C. H. K.

NEW SPECIES OF BEES OF THE GENUS DUFOUREA FROM CALIFORNIA

(Hymenoptera, Apoidea)

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University of California Citrus Experiment Station,
Riverside, California

The Californian fauna probably includes more species of *Dufourea* (inclusive of *Halictoides* and *Betheliella*) than is found in any other region. To the present time twenty species have been described from California, or are now known to occur in the state, not including the species recorded by Provancher (1895) as *Panurgus fimbriatus*. The present paper contributes thirteen additional species, and Mr. G. E. Bohart, who is working on the species of the northern and central part of the state, will describe nearly as many more. The species previously known from California (with type locality) are as follows:

mulleri (Cockerell) 1898 (*Halictoides*)
Trans. Amer. Ent. Soc. 25, p. 190 ..... Southern California

saundersi (Cockerell) 1898 (*Halictoides*) l. c.
p. 189 ..... Southern California

virgata (Cockerell) 1898 (*Halictoides*) l. c.
p. 191 ..... Southern California

davidsoni (Cockerell) 1902 (*Halictoides*)
Bull. So. Cal. Acad. Sci. 2, p. 140 ..... Bear Valley
San Bernardino Mts.

spinifera (Viereck) 1904 (*Cryptohalictoides*)
Ent. News, 15, p. 261 ..... Nevada

scintilla (Cockerell) 1916 (*Diandrena*)
Jr. Ent. & Zool. 8, p. 50 ..... Claremont

viridescens (Crawford) 1917 (*Halictoides*)
Insec. Insc. Menst. 4, p. 139 ..... Los Angeles County

calochorti (Cockerell) 1924 (*Betheliella*)
Ent. News, 35, p. 170 ..... Montgomery Creek

holocyanea (Cockerell) 1925 (*Halictoides*)
Proc. Cal. Acad. Sci. (4) 14, p. 199 ..... Baker, Oregon

spilura (Cockerell) 1925 (*Halictoides*)
l. c. p. 200 ..... Huntington Lake,
Fresno County

californica (Michener) 1936 (*Halictoides*)
Pan-Pac. Ent. 11, p. 181 ..... Yorkville,
Mendocino County

altadenae (Michener) 1937 (*Halictoides*)
Ann. & Mag. Nat. Hist. (10) 19, p. 395 ..... Altadena

australis (Michener) 1937 (*Halictoides*)
l. c., p. 398 ..... San Diego

bernardina (Michener) 1937 (*Halictoides*)
l. c., p. 401 ..... Tetley Park,
San Bernardino Mts.

boregoensis (Michener) 1937 (*Halictoides*)
l. c., p. 398 ..... Borego, San Diego County

eschscholtziae (Michener) 1937 (*Halictoides*)
l. c., p. 393 (=*scintilla* Ckll., new syn.) ..... Altadena

harveyi sierrae (Michener) 1937 (*Halictoides*)
l. c., p. 397 ..... Florence Lake, Fresno County

nemophilae (Michener) 1937 (*Halictoides*)
l. c., p. 400 ..... Tetley Park, San Bernardino Mts.

rhamni (Michener) 1937 (*Halictoides*)
l. c., p. 394 ..... Eagle Rock Hills, Los Angeles County

ruficauda (Michener) 1937 (*Halictoides*)
l. c., p. 397 ..... Altadena

sandhouseae (Michener) 1937 (*Halictoides*)
l. c., p. 328 ..... Altadena

Of the species described from southern California, all those recorded above are known to recent collectors except *saundersi* and *viridescens*. In regard to *saundersi*, there is some doubt that it was correctly labeled, and Dr. Cockerell informs me that it may have come actually from Sonora. The *Halictoides ilicifoliae* Ckll., described from Santa Clara County, has been recently taken in numbers both by Mr. Michener and myself, and should be cited as *Hesperapis ilicifoliae* (Ckll.).

The genus *Dufourea* was described by Lepeletier in 1841 (Hist. Nat. Insect. Hymén. 2, p. 227) with two species included, viz., *D. minuta* Lep. and *D. dejeanii* Lep. *D. minuta* may be taken as the genotype. *Halictoides* Nylander (Notis. Saellsk. faun. and fl. Fenn. Förh. 1, p. 195) was described in 1848 with two species, of which *H. dentiventris* Nyl. is regarded as the genotype. In view of the great diversity of structure of the mouthparts, legs and ventral segments of the abdomen in this group, it is not surprising that a considerable number of other generic and subgeneric names have been proposed, including *Betheliella* Cockerell (1924), *Conohalictoides* Viereck (1904), *Epihalictoides* Cockerell and Porter (1899), *Parahalictoides* Cockerell and Porter (1899), *Neohalictoides* Viereck (1904), *Cryptohalictoides* Viereck (1904), *Cephalictoides* Cockerell (1924) and *Mimulapis* Bridwell (1919).

The picture in regard to this diversity of structure and of names is closely paralleled by that of *Nomia*, of which Dr. Cockerell has given a good account (Proc. U. S. Nat. Mus. 38, p. 289–291, 1910). Thus, to place *Dufourea* on the same broad and conservative basis, on which *Nomia*, *Halictus*, *Andrena*, *Megachile* and various other bee genera now stand, it seems not

only logical but necessary to merge *Halictoides* and its numerous subgenera with *Dufourea*.

My views on the classification of *Dufourea* and allied genera and subgenera may be expressed in the following table, based primarily on the males.

1. Tergite 7 with a distinct, raised, pygidial area; abdomen with more or less dense erect hair on the tergum, which becomes depressed and fasciate at apex of segments. . . . . **Rhophites** Spinola

   Tergite 7 without a raised, pygidial area; abdomen sometimes with apical fasciae, but disk of tergites not especially hairy. 2

2. Genal space as long as wide; four basal joints of flagellum bulbously swollen, with pubescent excavation beneath. . . . . **Mimulapis** Bridwell

   Genal space very short; basal joints of flagellum normal. 3

3. Ventral segments of abdomen, especially ventrite 6, more or less modified, **Dufourea,** subg. **Halictoides** Nylander

   Ventral segments of abdomen (except the concealed 7th and 8th segments) entirely simple. 4

4. Male genitalia agreeing with *Halictoides*. Cardo more or less enlarged; stipites briefly joined at base, each with a long tapering lobe, variously modified; sagittae large, strongly arched at base where they are much elevated above basal part of stipital lobes; ventrites 7 and 8 each with a pair of basal articulating lobes, the apical lobes of 7 more or less depressed, nearly straight, never greatly longer than broad; 8 with a single median more or less elongate and compressed slender thorn-like lobe, **Dufourea** Lep. (s. str.)

   Male genitalia differing. Stipites with a common large dilated basal portion and each with a slender simple apical lobe; cardo subequal to dilated portion of stipites; sagittae rather small, arched at base, but hardly elevated above surface of stipites; ventrite 7 with a pair of basal articulating lobes, the apical lobes small, depressed, each with an elongate slender, strongly recurved or hooked appendage; ventrite 8 with a single median articulating lobe and a small fine terete apical lobe, **Dufourea,** subg. **Micralictoides**[1] nov.

The genera and subgenera of the above table all have similar genitalia and obviously have a common origin. *Rhophitoides* Schenk (type *R. canus* Eversm.) bears about the same relationship to *Rhophites* that *Halictoides* does to *Dufourea*. The new subgenus *Micralictoides* is based on two small species from southern California that are similar to the typical species of *Dufourea* from Europe, but differ as indicated in table. The two species included are *D. ruficauda* (Mich.), genotype, and *D. altadenae* (Mich.).

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The species of *Dufourea* of our North American fauna belong almost exclusively to *Halictoides*, the only exceptions being the

[1](Genotype, *Halictoides ruficaudus* Michener.)

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l. c., p. 398 ..... Borego, San Diego County

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   Genal space very short; basal joints of flagellum normal 3
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[1](Genotype, *Halictoides ruficaudus* Michener.)

two species noted above as belonging to *Micralictoides* and *D. leachi* described below. Our species of *Halictoides* are generally difficult to distinguish in the female sex, although the males are easily separated by diverse characters of the antennae, legs and ventral segments of the abdomen. In consequence the new species described below are based primarily on the male sex and several additional species represented only by females have been set aside until more material has been accumulated. The types of the new species at present are located in the collection of the Citrus Experiment Station, Riverside, California.

Dufourea leachi, n. sp.

This species appears to have no close ally in our fauna and may be recognized by the green color, short nodose antennae, simple legs and unmodified ventral segments 1 to 6.

Male.—Length, 6.25 to 6.5 mm. Head, thorax and abdomen dark blue-green. Antennae, legs and tegulae black. Broad depressed apical margin of tergites 1 to 6 shining testaceous. Mandibles black, reddened at apex. Tibial spurs pale testaceous. Wings very dusky (reddish), the stigma and veins dark brown, the subcosta blackish. Form moderately robust. Head rounded, somewhat wider than long. Inner orbits converging below. Vertex not prolonged behind the eyes and a line drawn tangent to hind margin of eyes would pass through ocelli. Antennae short, hardly reaching tegulae. Flagellum nude beneath, the joints about as thick as long, rather strongly nodose. Legs simple, joints 2 and 3 of hind tarsi somewhat produced behind. Disk of ventrite 6 without a median modified area, the apical margin acutely produced in middle. Face, vertex, mesoscutum and scutellum shining, closely and finely punctured. Mesopleura sparsely punctured. Basal area of propodeum short, longitudinally striate at sides, more closely and granularly striate in middle. Tergites rather closely punctured, except on the depressed apical margins. Venter closely but weakly punctured. Pubescence white or whitish, rather copious and moderately long, dense as usual on clypeus. Legs mainly with comparatively short, subdepressed hair. Abdomen with rather short, depressed hair, not forming bands.

The genitalia are distinctive: Cardo unusually large, longer than the basal united portion of stipites. Apical lobe of stipes slender, tapering, hairy and as long as the basal united portion, from which it appears to be separated by a distinct joint. Sagittal rods in the form of thin vertical laminate plates, widest at the middle, tapering and curved downward at apex, where they are closely opposed to each other, and widely separated near the base but curving around and joining across the middle at the base. Base of sagittae rather strongly elevated above surface of the stipites, but not so prominently as in our species of *Halictoides*.

Described from 19 males (***holotype*** and ***paratypes***), Mendocino County (E. R. Leach). Some of the paratypes will be returned to Dr. R. Meyer of Darmstadt, from whom they were received.

Dufourea (Halictoides) echinocacti, n. sp.

Comes nearest to *D. virgata* (Ckll.), but differs in the dilated front basitarsi and strongly depressed head which is longer than wide.

Male.—Length, 9.5 mm. Black, the frons slightly greenish. Abdomen slightly brownish, the venter distinctly brown. Apex of tergites rather narrowly translucent. Mandibles red at apex. Flagellum slightly reddened on outer side. Legs slightly rufescent, especially small joints of tarsi. Tibial spurs reddish-testaceous. Foveal depressions of clypeus rufescent. Tegulae black, the exposed posterior part of disk brownish. Wings dusky hyaline, the subcosta black, rest of veins and stigma dark brown. Form rather slender, the thorax, however, broader than in *D. virgata*. Head distinctly longer than wide, strongly depressed in front. Inner orbits very slightly diverging below. Clypeus very large, almost entirely anterior to eyes, a little more than twice as wide as long, shallowly foveate on each side above. Labrum large, convex. Mandibles with an acute inner tooth. Tongue long and slender, nearly as long as head. Vertex broad behind the eyes, so that a line drawn tangent to posterior margin of eyes would intersect the anterior part of median ocellus. Antennae short, reaching about apex of tegulae. Flagellum hardly crenulate and joints 6 to 10 beneath with a few outstanding, moderately long curled hairs, a little thickened at apex. Middle joints of flagellum about as long as thick, but joints 1, 2 and 11 longer than wide and subequal. Mesonotum rather strongly depressed. Front and middle femora swollen, thicker than hind pair. Front basitarsi dilated, subtriangular, obliquely truncate on inner side at apex, concave and almost nude above, densely hairy and convex beneath. Following joints of front tarsi normal. Outer side of front tibiae at apex with a few red spines. Middle tibiae with more numerous red spines, mostly on apical and lower margins. Hind tibiae clavately swollen, thickest at one-fourth of the length from apex and abruptly narrowed beyond on the inner side. Joints 2 to 4 of hind tarsi triangularly produced behind. Abdomen narrow, tapering to apex. Ventrites 1 to 5 normal. Ventrite 6 without a distinct median area, but with a triangular median apical lobe, which is somewhat tectiform. Clypeus broadly impunctate around margins, otherwise with minute dense punctures. Frons and vertex finely punctured, the punctures not all of one size. Area just above antennae more finely and densely punctured and some finer punctures in front of ocelli. Upper part of frons on each side and sides of vertex closely, the transverse middle of frons more sparsely, punctured. Mesonotum polished, minutely, rather sparsely punctured. Posterior middle of scutum very sparsely punctured. Enclosure of propodeum with fine close longitudinal striae, the continuation of the area on the

truncation with cross striae. Abdomen finely, closely punctured, the punctures more distinct on first two tergites and sparser on tergite 1. Pubescence pale ochraceous, long and copious on lower part of cheeks, under side of mandibles, occiput, pleura, metanotum, anterior margin of mesoscutum, sides of propodeum, apical lobe of ventrite 6 and on front and middle femora and tibiae. Hind legs with comparatively short sparse hair. Anterior surface of head thinly pubescent, the clypeal hair short, not obscuring surface. Hair of abdomen short, subappressed, becoming whiter and forming a thin band at base of tergites 2 to 6. On each side of face just above clypeus are several fuscous hairs and hair on disk of tergite 6 also blackish.

Female.—Length, about 10 mm. Similar to male, except in usual sexual characters. Flagellum distinctly reddened on outer side except at base. Labrum and sometimes anterior margin of clypeus reddish brown. Head distinctly longer than wide, depressed, as in male. Inner orbits conspicuously diverging below. Puncturation of frons, vertex, mesonotum and tergites, closer. Clypeus sparsely punctured, the anterior half impunctate. Supraclypeal area impunctate in middle. Enclosure of propodeum more finely and densely striate, with cross striae at apex (cross striae not confined to continuation of area on the truncation as in male). Red spines present on front and middle tibiae as in male. Pubescence tinged with ochraceous and rather copious. Base of tergites 2 to 5 with a distinct white hair-band. Hair at apex of tergite 5 reddish ferruginous. Thin hair of upper part of frons and vertex blackish and the rather long hair on disk of tergite 5 fuscous. Hair on inner side of tarsi pale golden ferruginous.

Described from 2 males and 2 females. *Holotype* male from Palm Canyon, Riverside County, March 9, 1924 (H. S. Smith). *Allotype* from same locality, at flowers of *Echinocactus acanthodes*, April 3, 1925 (Timberlake). Paratype male from same locality and flower, April 15, 1938 (R. M. Bohart). Paratype female at same flower, 24 miles west of Kane Springs, San Diego County, March 25, 1933 (Timberlake).

Defourea (Halictoides) vernalis, n. sp.

Allied to *D. echinocacti*, but distinguished by having the head as broad as long, not much depressed, clypeus and supraclypeal area with dense white hair, and middle tibiae with long white hair and not conspicuously spinose on outer side.

Male.—Length, 9.5 mm. Black, the frons and vertex with a barely perceptible greenish tinge or quite black. Outer side of flagellum, except base, slightly rufescent. Tibial spurs testaceous. Tegulae black, becoming translucent brownish posteriorly. Wings slightly dusky, the veins and stigma nearly black. Form rather slender, but not quite as in *D. virgata*. Head as broad as long, with a broad frons. Inner orbits nearly parallel. Clypeus and labrum normal. Foveae on dorsal part of

clypeus prominent. Vertex broad behind the eyes and a line drawn tangent to hind margin of eyes would nearly or quite clear the anterior margin of median ocellus. Tongue moderately long. Mandibles with acute inner tooth. Antennae reaching base of scutellum. Flagellum somewhat crenulate, its joints mostly about one and one-half times longer than thick. Joint 1 of flagellum much the shortest and 2 a little longer than the others. Joints 3 to 10 each with a few long curled hairs beneath, which are sparser on the more basal joints, 3 having only one to three hairs. Front basitarsi dilated, subquadrate, about twice as long as wide, slightly concave on outer side with long sparse white hairs, and convex beneath with short dense hair. Front and middle femora more strongly swollen than hind pair. Hind tibiae as in *D. echinocacti*, but more slender, with the widest part closer to the apex. Joints 2 and 3 of hind tarsi a little produced behind. Abdomen tapering behind. Ventrite 4 with two mintue subapical papilla-like tubercles, about as close together as to side margins of segment. Apical margin of ventrite 5 slightly emarginate in middle. Median area of ventrite 6 hardly differentiated except by being depressed. Apical lobe of ventrite 6 rather small, depressed, rather broadly flame-shaped. Clypeus densely punctured, except narrow anterior margin. Frons and vertex densely punctured, the punctures closest in region between lateral ocelli and nearest eye-margin. Mesonotum with finer much sparser punctures than vertex, the punctures, nevertheless, numerous and evenly distributed. Enclosure of propodeum short, crescentic, with fine longitudinal striae, sparser toward each side. Tergites as coarsely punctured as frons, the punctures becoming sparser on apical half of disk. Pubescence white, long and copious on face, clypeus, cheeks, lower margin of mandibles, occiput, most parts of thorax and the legs. Hair of middle tibiae longer and denser than on other parts of legs. Hair on under side of basitarsi golden ochraceous. Long hairs on each side of face below antennae, black. Upper part of frons with much sparser, shorter, somewhat blackish hair. Long hair of vertex and scutellum tinged with pale brown. Hair of abdomen short and whitish, a little longer on first two tergites. Disk of tergite 6 with fuscous hair, and that on 5 sometimes partly fuscous. Basal hair-bands little apparent, although lateral patches may show at base of tergites 2 to 4. Tuft of hair on apical lobe of ventrite 6 short and inconspicuous.

Female.—Length, about 9 mm. Similar to male, except in sexual characters. Head as broad as long, the clypeus rather produced in front of eyes, almost exactly as in *D. virgata*. Clypeus convex, very sparsely punctured. Frons and vertex densely punctured. Mesonotum more finely and not so densely punctured as frons. Integument black, the frons and vertex barely greenish. Flagellum reddish brown on outer side except at base. Pubescence white, considerably shorter on head and thorax than in male. Hair of part of frons and vertex pale fuscous or brownish. Hair on disk of tergite 5 tinged with fuscous. Base of tergites 2 to 5 with a distinct white hair-band. Dense hair at apex of 5 pale ferruginous. Hair along dorsal margin of hind tibiae and on outer side of hind basitarsi, especially at apex, fuscous. Hair on outer side of middle tibiae at apex and on outer side of middle basitarsi also partly fuscous.

Described from 4 specimens collected as follows: *Holotype* male, at flowers of *Eschscholtzia minutiflora*, var. *darwinensis*, Salt Creek, Chocolate Mountains, Imperial County, March 20, 1927 (Timberlake). Paratype male, Lost Palm Canyon, Riverside County, April 2, 1937 (Dammers). Paratype male, on *Phacelia distans*, Lovejoy Butte, 7 miles north of Llano, Los Angeles County, May 3, 1937 (Timberlake). *Allotype* female, on *Eschscholtzia minutiflora*, var. *darwinensis*, 28 miles south of Twenty-nine Palms, April 14, 1935 (Timberlake).

Durfourea (Halictoides) linanthi, n. sp.

Allied to *D. californica* (Mich.) but separable by the black color, by having a small tuft of white hair on each side of the apical margin of ventrite 5, and by numerous other small differences. The species of this immediate alliance are distinguished from *D. sandhouseae* (Mich.) and allies by having the modified hairs on the under side of the flagellum very numerous, short and fine.

Male.—Length, 4.5 mm. Black, the frons and vertex faintly bluish in some specimens. Mandibles red at apex. Flagellum dull brownish on outer side except at base. Venter more or less brownish. Apical margin of tergites whitish subhyaline. Tibial spurs yellowish white. Wings dusky hyaline, the veins and stigma dark brown. Form rather robust. Head nearly rotund, about as broad as long. Inner orbits of eyes converging below. A line drawn tangent to hind margin of eyes would pass through ocelli. Antennae reaching propodeum, the joints of flagellum about twice as long as wide. Joint 2 of flagellum slightly longer than following joints. Joint 1 of flagellum shorter and slenderer than the others, yet distinctly longer than thick. Flagellum robust, hardly crenulate, not flattened beneath, but bearing on under side very numerous fine curled hairs, which are much shorter than the thickness of the joints. Legs rather slender, without special modifications, except that the spur of middle tibiae is dilated at end, and the middle basitarsi are unusually slender and arcuate. Ventrite 5 broadly emarginate at apex and bearing at apical corners a small tuft of whitish hair. Ventrite 6 gradually narrowed from the base to a rather broad subdepressed apical lobe which is abruptly narrowed near apex to form an angle of about 90 degrees. Middle of the disk of this sclerite with a narrow triangular soft pale area which extends on to the base of the apical lobe. Clypeus densely punctured. Frons with fine, moderately dense punctures, those of the vertex considerably sparser. Punctures of mesonotum like those of frons but closer, mostly about one and not more than two puncture-widths apart. Enclosure of propodeum short, crescentic, the longitudinal striae rather coarse. Tergites rather closely punctured. Pubescense whitish, mostly rather short, but abundant, more suggestive of a female than the usual male *Halictoides*. Clypeus and supraclypeal area

with dense subappressed white hairs. Hair of legs not especially copious, except on the under side of hind tibiae, where it is long. Tergites 1 to 5 each with a distinct white apical hair-band, more or less interrupted in middle on 1 and 2. Exposed parts of tergites 6 and 7 with similar but longer hair. Disk of ventrite 6 and its apical lobe nearly nude, but the margin of the lobe has a moderately long fringe of pale hairs.

Female.—Length, about 4.5 mm. Similar to male, but more robust and differing in usual sexual characters. Black, the frons with a barely discernible greenish tinge. Flagellum reddish brown except broadly at base. Venter blackish. Frons, vertex and mesonotum equally finely, densely punctured. Clypeus sparsely and considerably more coarsely punctured than frons. Tergites more sparsely punctured than mesonotum. Pubescence grayish white, becoming very short and rather dense around margins of mesoscutum but sparse on disk. Tergites 1 to 4 with a distinct whitish hair-band, covering the apical depression, and without trace of basal bands. Band on tergite 1 interrupted (or perhaps worn) in middle. Apical part of tergite 5 with longer dull white hair, somewhat band-like, and becoming at the middle of the margin very dense and ferruginous. Similar to the female of *D. californica* in size and sculpture, but black instead of green, the head slightly longer than wide instead of broader than long, the abdomen much more punctured, with stronger bands, etc. From two other Californian females with apical hair-bands it differs thus: From *D. virgata* (Ckll.) in the much smaller size, short tongue and palpi, short dense hair on margins of mesoscutum, stronger hair-bands and much smaller ferruginous tuft at apex of tergite 5. From *D. australis* (Mich.) it differs in its small size, comparatively nude disk of mesonotum and in the short striate enclosure.

Described from 10 males (*holotype* and *paratypes*) on *Linanthus aureus*, Tujunga Wash, Los Angeles County, April 17, 1927 (Timberlake); 1 paratype male, Keen Camp, San Jacinto Mts., June 6–12, 1917 (E. P. Van Duzee); *allotype* female, Herkey Creek, San Jacinto Mts., on *Linanthus lemmonii*, June 8, 1937 (Timberlake); and 4 paratype males, the Gavilan, Riverside County, on *Linanthus dianthiflorus*, April 27, 1938 (Timberlake).

Dufourea (Halictoides) brevicornis, n. sp.

Allied to *D. californica* (Mich.) and *D. linanthi* Timb., but it is easily distinguished by the short, thick antennae, with a long scape and joints of flagellum broader than long. It might be confused with *D. sandhouseae* (Mich.), but the scape is much longer, the flagellum not broadened at base, and the numerous hairs on its under surface much shorter.

Male.—Length, about 5.5–6 mm. Black, including antennae, legs and tegulae. Frons with a bluish or blue-green luster. Mesonotum with a metallic iridescence. Tibial spurs pale testaceous. Wings dusky

hyaline, the stigma and veins blackish. Depressed margin of tergites subhyaline but not conspicuously pallid. Form moderately robust. Head rounded, as broad as long. Vertex not prolonged behind eyes, the supraorbital line passing through ocelli. Antennae short, hardly reaching tegulae. Scape unusually long, comprising about one-third the total length of antenna, rather broad, compressed. Flagellum very short, distinctly compressed, but hardly more flattened beneath than above, clothed beneath with numerous short, not much curled, hairs, that are shorter than the thickness of joints. Joints of flagellum, except the last, broader than long, not at all nodose. Legs simple, joints 2 to 4 of hind tarsi somewhat produced behind. Ventrites 1 to 5 simple. Ventrite 6 with a median depressed, more or less testaceous area, along the sides of which are two converging ridges, meeting at apex. Continuous with median area is a pale ferruginous apical lobe, a little longer than wide and distinctly but not deeply emarginate at apex. Sides of frons and of vertex finely and closely punctured, the punctures becoming considerably sparser and coarser toward the middle of the frons, where there is a median impunctate space just below ocelli. Mesonotum shining, a little more finely and much more sparsely punctured than sides of frons. Pleura obscurely punctured. Enclosure of propodeum short, crescentic, smooth at apex, the longitudinal striae short and not crowded. Abdomen shining. Tergite 1 almost impunctate; 2 with a few widely spaced delicate punctures; following segments successively more and more punctured. Pubescence whitish, copious, moderately long on head, thorax and legs. Clypeus and base of labrum with shorter depressed hair, which is sparser than a band of similar hair on supraclypeal area. Hair of front legs short and sparse, that of the other legs much more copious. Hair of abdomen short, mostly depressed, becoming more abundant on apical segments, the disk of first two tergites nude. Apex of ventrite 6 with short fine hair.

Female.—Length, 6 mm. Similar to the male. Black, the head greenish, the mesonotum with a hardly discernible bluish tinge. Apex of tergites very broadly testaceous hyaline. Flagellum reddish-brown beneath. Head slightly wider than long. Clypeus with coarse striate punctures, but smooth on anterior part. Frons and vertex strongly and moderately closely punctured. Mesonotum shining, the punctures distinctly finer and slightly more separate than those of frons. Tergites minutely punctured, 1 almost impunctate, base of 2 closely and rest of disk sparsely punctured, the following segments more closely punctured. Pubescence whitish, the apical fimbria bright ferruginous. Mesonotum with moderately dense hair, nearly uniformly distributed and with longer erect hairs interspersed. Apex of tergites 2 to 4 with thin hair not forming a distinct fascia. Base of at least tergites 2 and 3 with a thin but distinct white band. May be distinguished from our other small black species by the coarsely punctured clypeus and unusually broad pale margin of tergites.

Holotype male collected at flowers of *Linanthus dianthiflorus*, the Gavilan, Riverside County, April 17, 1938 (Timberlake); *allotype* female, San Diego County, March 22, 1914 (E. P. Van

Duzee); and the following paratype males: 1 collected with the allotype and 10 from the type locality collected April 17, April 27 and May 4, mostly on *Linanthus dianthiflorus* but one on *Cryptantha intermedia* and one taken flying over ground.

Dufourea (Halictoides) calientensis, n. sp.

Closely allied to *D. sandhouseae* (Mich.) but distinguished by the much longer antennae and by lacking the dense brush of white hair on base of mandibles.

Male.—Length, 5–5.5 mm. Head, thorax and abdomen dark green, or blue-green. Legs black, venter brownish. Apex of tergites narrowly whitish hyaline. Flagellum reddish-brown beneath, except at base, and on outer side toward apex. Tegulae translucent brown, darker at base. Wings dusky hyaline, with a reddish tint as in *sandhouseae*. Veins and stigma slightly paler brown than in that species. Stigma in both species darker on outer margin. Form as in *sandhouseae*. Head nearly the same, but vertex more produced behind eyes and a line drawn tangent to hind margin of eyes would nearly clear ocelli. Antennae about reaching metanotum, the joints of flagellum mostly slightly longer than wide. Flagellum strongly flattened beneath, as in *sandhouseae*, but more slender. First two joints not quite as wide as following joints and tapering a little toward pedicel, the first twice as long as wide. (In *sandhouseae* joints 1 and 2 broader than following joints). Long hair on under side of flagellum abundant, longest on joints 3 to 5, moderately long on following joints, but gradually shortening toward base of flagellum. Legs essentially as in *sandhouseae*. Tubercles near apical corners of ventrites 3 and 4 obscure, those on 4 bearing a minute spicule. (Tubercles on 3 and 4 each bearing a spicule in *sandhouseae*). Ventrite 5 less strongly emarginate. Ventrite 6 similar to *sandhouseae*, but apical lobe a little smaller, more depressed, with a shorter, less conspicuous tuft of hair. Sculpture similar to *sandhouseae*, but frons and vertex more sparsely and more uniformly punctured. (Punctures in *sandhouseae* sparse on middle of frons and dense on each side above in region between each eye and ocelli). Mesonotum more sparsely punctured, the punctures mostly at least two puncture-widths apart. Tergites more weakly and more sparsely punctured. Pubescence as in *sandhouseae*, except that the base of mandibles lacks the dense brush of whitish hair characteristic of that species.

Female.—Length, about 5.5 to 6 mm. Hardly distinguishable from *sandhouseae*, but the abdomen greener, more weakly punctured. Color and sculpture otherwise, and pubescence offer no good characters, but the form of the clypeus appears to be distinctive. In *sandhouseae* the clypeus, as seen directly from above (angle of vision perpendicular to disk) appears rather deeply and broadly emarginate, the emargination limited on each side by a short but evident angular lobe. In *calientensis* the emargination much less evident and lateral lobes shorter and blunter, with their inner margin longer and sloping more gradually mesad. (This character not apparent in all specimens as the labrum obscures the view unless it is depressed).

Described from 5 males, 10 females (*holotype* male, *allotype* and *paratypes*) collected at flowers of *Eschscholtzia californica*, Caliente, Tehachapi region, Kern County, March 24, 1932 (Timberlake).

Dufourea (Halictoides) malacothricis, n. sp.

Similar to *D. sandhouseae* (Mich.), but smaller and distinguishable by the thicker flagellum and lack of dense pale hair on base of mandibles. Both sexes have the flagellum brighter orange-ferruginous than in other species.

Male.—About 4.5–5.5 mm. Head and dorsum of thorax dark blue-green, the rest of thorax and abdomen black, with at most a slight greenish luster. Apical margin of tergites whitish hyaline. Scape and pedicel black, the flagellum bright orange-ferruginous, a little darker above, where the first one or two joints are nearly black. Tegulae rather pale translucent brown, darker at base. Wings slightly dusky, the veins and stigma dark brown, the subcosta blackish. Margins of stigma darkened. Small joints of tarsi rufescent. Head shaped nearly as in *sandhouseae*. Supraorbital line intresecting anterior ocellus. Antennae not surpassing tegulae. Flagellum greatly flattened beneath and bearing numerous long curled hairs, which become only a little shorter and sparser on the first and the last joint. Middle joints of flagellum about twice as broad as long, the flagellum increasing slightly in width from the first to the eighth joint, the first two joints about as long as wide. Ventrite 4 bearing a pair of minute spicule-bearing tubercles subapically, a short distance from the sides. Ventrite 5 roundly produced at apex. Ventrite 6 having the paler median area widened toward apex (instead of narrowed as in *sandhouseae*), the margins of dark area on each side continuous with margins of apical lobe or sometimes curving off laterad near the middle of the segment. Apical lobe of ventrite 6 broad (several times larger than in *sandhouseae*), thin, depressed, rounded at apex and covered with long white hair. Legs nearly as in *sandhouseae*. Puncturation definitely finer and sparser on head and thorax than in *sandhouseae*. Punctures of frons and vertex nearly uniform, moderately close, except in area behind ocelli, where they are obsolescent. Punctures of mesonotum fine, rather sparse, sometimes very sparse on posterior middle of scutum. Enclosure of propodeum polished, the striae generally rather sparse and not quite reaching the margin. Punctures of abdomen finer than in *sandhouseae* but about as close. Pubescence white, hardly differing from *sandhouseae* except that the base of mandibles lacks the dense hair-brush.

Female.—Length, 4.5–6 mm. Similar to the female of *sandhouseae*, but averaging smaller in size and differing in the bright orange-ferruginous flagellum, which is infuscated above on only the first two or three joints. Puncturation of the head and mesonotum a little sparser, especially of the scutum. Emargination on front margin of clypeus less developed, with lateral lobes much less produced. Wings distinctly clearer.

Described from 2 males, 5 females (*holotype* male, *allotype* and *paratypes*), on *Malacothrix californica*, var. *glabrata*, Whitewater, Riverside County, April 2, 1927 (Timberlake).

Also the following paratypes: 4 males, Palm Springs, on *Oenothera bistorta*, var. *hallii*, March 21; 7 males, 16 females on *Malacothrix glabrata*, Borego Valley, March 26, the females collecting pollen; 2 females, 4 miles south of Twenty-nine Palms, on *Malacothrix glabrata* and *Eschscholtzia darwinensis*, April 14; 4 males, 10 miles south of Twenty-nine Palms, on *Malacothrix glabrata*, April 14; 1 male, 1½ miles west of Adelanto, on *Anisocoma acaulis*, April 25 (all Timberlake); 1 male, Adelanto, April 11 (C. M. Dammers); 1 male, 1 female, 9 miles north of Adelanto, April 20 (Dammers); 9 males, 3 females, Banning, April 16 (Bohart); 1 male, Mojave, April 11 (Bohart); 1 female, Lone Pine, Inyo County, April 18; and 2 females, 4 miles west of Lone Pine, Inyo County, 4800 feet, May 19 (C. D. Michener).

Dufourea (Halictoides) dammersi, n. sp.

This and the next two species (*desertorum* and *latifrons*) are medium-sized, black species, with the male flagellum definitely not flattened beneath and provided with a limited number of long curled hairs. By these characters they differ from *D. sandhouseae* (Mich.) and allies.

D. dammersi is similar to *D. australis* (Mich.) but distinguished by the striate enclosure. *D. oryx* (Vier.) is another similar species, but distinctly green.

Male.—Length, 8 mm. Black, including antennae, legs and tegulae. Mandibles reddish at apex. Tibial spurs pale testaceous. Depressed margin of tergites a little translucent but not conspicuously pale. Wings somewhat dusky (grayish) hyaline, the veins and stigma almost black. (In *australis* wings darker, more reddish, the veins and stigma by comparison much more brownish and the tegulae also brownish). Form rather slender. Head as long as wide, the clypeus not produced. Inner orbits converging below. Vertex rather long behind eyes and supraorbital line passes slightly in front of ocelli. Antennae rather long, reaching base of propodeum. Flagellum subcylindrical, moderately thick, slightly crenulate, the middle joints rather less than twice as long as wide. (Flagellum in *australis* more strongly crenulate). First joint of flagellum, as long as wide, the second a little longer than the following. Joints 3 to 11 with a row of long, strongly curled hairs beneath, about five to each joint, becoming shorter and finer on distal and proximal joints. There is also a row of very fine close hairs just above and exterior to the long hairs. Legs slender, simple. Ventrite 5 very slightly emarginate at apex. Ventrite 6 with a very narrow shining triangular median

area, continuous with a short keel-like apical process. Frons finely, very closely punctured, the punctures becoming a little coarser and sparser on vertex. Mesonotum shining, finely punctured, the punctures mostly about one puncture-width apart. Enclosure of propodeum large, defined laterally by a straight oblique carina. Median part of enclosure dullish, with an irregular anastomosing striae, forming a rugose reticulation. Laterally the striae are more regular and the surface more shining. Tergites with rather close punctures, those on disk of tergite 1 about as coarse as those on vertex, but those on apical segments becoming gradually finer. Pubescence white, copious, but not especially long, becoming sparse on upper part of frons and ocellar region. Hair of legs abundant but rather short. Abdomen with short subdepressed hair, without indication of bands either at base or apex of tergites. Some inconspicuous fuscous hair on disk of tergites 5 and 6. (Pubescence in *australis* more ochraceous, a little longer and more erect on abdomen, with much more blackish hair on apical tergites).

Holotype male collected April 2, 1937, at Lost Palm Canyon (near Desert Center), Riverside County (C. M. Dammers).

Dufourea (Halictoides) desertorum, n. sp.

This species differs from *D. dammersi* in the shorter antennae and ferruginous flagellum.

Male.—Length, 7 mm. Shining black. Flagellum ferruginous brown on outer surface, except basal joint. Mandibles red at apex. Spurs testaceous. Depressed margin of tergites 1 to 6 whitish translucent. Tergite 7 reddish. Median area and apical process of ventrite 6 pale ferruginous. Tegulae rather pale brown, more translucent on margin and darker at base. Wings nearly clear hyaline. Subcosta and stigma blackish, the latter with reddish brown streak in middle. Rest of veins mostly dark brown. Form rather slender. Head distinctly longer than wide, the clypeus strongly produced in front of eyes. Inner orbits converging below. Head lengthened behind the eyes and strongly narrowed caudad, the supraorbital line just grazing anterior margin of median ocellus. Mandibles with an acute inner tooth. Antennae reaching slightly beyond tegulae. Flagellum subcylindrical, not at all crenulate, slightly narrowed basad. Joints 1 to 9 of flagellum each with about two or three long curled white hairs beneath. Joint 1 shortest, slightly longer than thick. Joint 2 nearly twice as long as 1. Joints 3 and 4 somewhat shorter than 2. Following joints also slightly shortening successively, the penultimate and antepenultimate about as long as thick. Joint 11 as long as 3 or 4. Femora slightly swollen and joints 2 to 4 of hind tarsi somewhat produced behind. Ventrites 3 and 4 with a small spicule-bearing tubercle near apical corners. Ventrite 5 roundly emarginate at apex. Ventrite 6 with a distinct wide median area, with nearly parallel sides and produced at apex into a depressed lobe. This apical lobe angulated at apex and covered with a tuft of long white hair. Clypeus, except apical margin, densely punctured. Frons and vertex with strong close punctures, mostly about one puncture-width apart,

those on middle of frons finer. Immediate area surrounding ocelli mostly impunctate. Mesoscutum finely, rather sparsely punctured. Scutellum a little more closely punctured. Enclosure of propodeum short, subcrescentic, with rather few, coarse, separate striae, not reaching margin. Disk of tergite 1 and subapical part of tergites 2 to 6 sparsely punctured, the base of 2 to 6 more closely punctured. Pubescence white, moderately copious (considerably worn in type). Clypeus and supraclypeal area covered with white hair. A few blackish hairs on sides of face below antennae and hair on under side of scape somewhat darkened. Hair on under side of front and hind femora and hind tibiae long and copious. Hair of abdomen short, depressed, entirely white and rather sparse (but worn).

Female.—Length, 7 mm. Similar to the male. Black. Flagellum reddish brown on outer side except toward base. Wings somewhat dusky (grayish), the veins and stigma blackish. Head distinctly longer than wide. Inner orbits parallel. Clypeus with rather coarse sparse punctures. Sides of face opposite antennae and lower part of frons sparsely punctured. Punctures of rest of frons and vertex close, mostly about one puncture-width apart. Punctures of mesonotum slightly finer and a little less close than those of frons. Enclosure of propodeum with fine dense striae, the sublateral striae curving mesad and joining across the apex. Punctures of tergites fine and sparse, but becoming close at base of 2 and 3. Pubescence white, most prominent on cheeks, under side of thorax and legs. Some conspicuous pure white hair between clypeus and antennal sockets. Some fuscous or blackish hair on sides of face below antennae, on scapes and upper part of frons and vertex. The long erect hairs of mesonotum mostly fuscous, but no dark hair on abdomen. Base of tergites 2 to 5 with a narrow white hair-band. Hair tuft at apex of tergite 5 dull ferruginous. Dorsal margin of hind tibiae with some fuscous hair. Hair on inner side of tarsi golden.

Holotype male at flowers of *Eschscholtzia minutiflora*, var. *darwinensis*, 29 miles south of Twenty-nine Palms, April 14, 1935; 2 females (*allotype* and *paratype*) at same flower, 24 miles west of Kane Springs, March 25, 1933 (Timberlake).

Dufourea (Halictoides) latifrons, n. sp.

D. latifrons resembles *desertorum* in pale ferruginous flagellum, but differs in the broad head, simple mandibles and bifurcate process of apical lobe of sixth ventrite.

Male.—Length, 7–8 mm. Shining black, the frons faintly bluish. Claws and apex of mandibles reddish. Spurs pale testaceous. Flagellum yellowish ferruginous on outer side, except at base. Tegulae black, translucent dark brown behind. Depressed margin of tergites 1 to 6 pale brownish translucent. Wings clear hyaline, the veins and stigma nearly black. Head rotund, a little broader than long. Inner orbits parallel, the area included from anterior margin of clypeus to median ocellus distinctly broader than long. Clypeus hardly produced, short and transverse. Mandibles broadened on inner margin before the apex,

but not notched or toothed. Antennae reaching about hind margin of tegulae. Flagellum subcylindrical, weakly crenulate, somewhat slenderer basad, clothed beneath with a few long curled whitish hairs, arranged in groups mostly of three or four hairs near apex of joints 1 to 10. These hairs considerably shorter on joints 1 and 10. Joints 2 to 11 of flagellum subequal in length, 2, 3 and 4 barely longer than thick, the others about as long as wide. Joint 1 somewhat shorter than others and as long as wide. Ventrite 4 with a pair of minute spicules, hardly tuberculate at base, each placed subapically, a short distance in from lateral margin. Ventrite 5 with a rounded emargination at apex, the sinus about half as broad as width of segment, its margin testaceous. Ventrite 6 with a depressed median area, distinctly narrowed caudad, where it is continuous with a small projecting subquadrate lobe, somewhat broader than long and rounded at apex. This apical lobe armed with a chitinous bifid process, projecting at a slight angle, the two teeth very acute and somewhat surpassing true apex of lobe. Apical lobe clothed with rather short hair on all parts except teeth of bifid process. Legs rather slender, hardly modified, the middle joints of hind tarsi slightly produced behind. Clypeus, except apical margin, closely punctured. Punctures of face strong, but rather fine, mostly about one to two puncture-widths apart on frons, and sparser on middle of frons and on vertex. Mesonotum with finer, sparser punctures than frons, those on middle of scutum more or less widely spaced. Enclosure of propodeum short, subcrescentic, rather strongly concave, dullish, with fine dense striae, which become coarser and separate far to the sides. Disk of tergites with fine, moderately close punctures, which are hardly sparser subapically than at base of segments. Pubescence whitish, moderately long and copious. All femora and hind tibiae beneath with long white hair. Hair of upper part of frons slightly tinged with pale brown, shorter and sparser than on other parts of head. Hair of abdomen mostly short, subdepressed, with little or no indication of either basal or apical hair-bands.

Described from 2 males (*holotype* and *paratype*) collected at flowers of *Oenothera clavaeformis*, Thousand Palms, Riverside County, March 14, 1937 (Timberlake); and 2 males (paratypes) on *Oenothera*, Edom, March 14, 1937 (Bohart).

Dufourea (Halictoides) truncata, n. sp.

This species belongs to a group having flagellum nude beneath, legs hardly modified, and sixth ventrite with a distinct depressed median area, the previously known Californian species being *D. scintilla* (Ckll.), *D. rhamni* (Mich.) and *D. boregoensis* (Mich.). *D. truncata* differs in having a chitinized, rather prominent, truncate process, constituting the apical lobe of sixth ventrite.

Male.—Length, about 5.5 mm. Black, the anterior surface of head dark blue, the mesonotum often showing a distinct metallic iridescence.

Mandibles red at apex. Apex of tarsi slightly rufescent. Spurs pale testaceous. Flagellum pale ferruginous brown on outer side except toward base. Depressed margin of tergites subhyaline, a little whitish. Apical process of ventrite 6 reddish. Tegulae translucent brown, blackish at base. Wings rather dusky, with a reddish tinge. Stigma and veins brown, the subcosta black. Head subrotund, somewhat broader than long. Clypeus hardly produced, short, transverse. Inner orbits of eyes slightly converging below. Supraorbital line passing through ocelli. Antennae nearly reaching base of scutellum. Flagellum subcylindrical, slightly clavate, neither distinctly nodose nor crenulate, and nude beneath. Joints of flagellum about as long as thick, subequal, except the last, which is slightly longer. Collar of pronotum distinctly angularly produced on each side (not at all in *scintilla*, *rhamni* and *boregoensis*). Legs hardly modified, although middle femora are dilated beneath and hind femora rather swollen. Middle joints of hind tarsi slightly produced behind. Ventrite 4 with a minute spicule subapically on each side. Ventrite 5 not emarginate. Ventrite 6 with the median depressed area broad, nude, somewhat narrowed caudad, where it is continuous with a chitinized inclined plate, elevated and truncate-emarginate at apex and nearly twice as broad as long. Disk of plate nude, but the margins, both lateral and apical, fringed with moderately long hair. Clypeus, except apical margin, densely punctured. Punctures of middle of frons and ocellar region fine and sparse, those of sides of frons and vertex much closer. Mesonotum with fine punctures, mostly about two to three puncture-widths apart. Enclosure of propodeum short, crescentic, with rather coarse, more or less separate striae. Tergite 1 nearly impunctate. Following tergites very finely, rather sparsely punctured, the punctures becoming sparser and subobsolete subapically. Pubescence white, long and copious on face below antennae, on scapes, cheeks, thorax and legs, and forming a fringe-like band at base of tergites 2 to 6.

Female.—Length, 5.5 mm. Similar to male. Black, the head anteriorly distinctly green or blue-green, and the mesonotum with a changeable greenish and purple luster. Flagellum reddish-brown on outer side, except base. Head subrotund, slightly broader than long. Inner orbits parallel. Frons and vertex shining, finely and closely punctured, the punctures somewhat sparser on middle of frons. Mesonotum with fine, nearly uniformly spaced punctures, about one to two puncture-widths apart. Enclosure of propodeum with much finer and closer striae than in male, the striae not quite reaching apex and one or two on lateral margins curving inward and joining across the apex. Tergite 1 nearly impunctate. Following tergites finely punctured on basal half. Pubescence shorter and sparser than in male, tinged with ochraceous on top of head and thorax, and slightly pale brownish on vertex and scutellum. Base of tergites 2 to 5 with a whitish fringe-like band. Hair on disk of tergite 5 sometimes fuscous, the dense apical tuft bright ferruginous.

Described from 3 males, 2 females (***holotype*** male, ***allotype*** and ***paratypes***) collected April 18, 1937, at or flying near the

flowers of *Oenothera bistorta*, var. *veitchiana*, 1½ miles west of Perris, Riverside County (Timberlake). In 1938 the following paratypes were taken: 25 males, 10 females, collected April 1, 8, 17, 27 and May 4, at type locality, at flowers of *Oenothera* and *Cryptantha intermedia;* and 3 males, on *Cryptantha*, at the Gavilan, Riverside County, April 17 (Timberlake).

D. truncata flies with *D. scintilla* (Ckll.) at the same flowers, and while hardly distinguishable in the field, *D. scintilla* is easily separated under a lens by the much greener color, rounded corners of the pronotum, and short depressed apical lobe of sixth ventrite.

Dufourea (Halictoides) nudicornis, n. sp.

This species is most similar to *D. boregoensis* (Mich.), but considerably larger, with the antennae somewhat shorter, the flagellum more clavate and more nodose.

Male.—Length, about 7 mm. Black, the frons slightly greenish. Mandibles red at apex. Flagellum rather pale ferruginous brown on outer side, except basal joint. Spurs pale testaceous. Tegulae translucent brown, darker at base. Wings almost clear hyaline. Stigma and veins brown, the subcosta darker. Depressed margin of tergites 1 to 6 whitish or testaceous. Form rather slender. Head subrotund, about as long as wide. Clypeus only slightly produced. Inner orbits not converging below. Supraorbital line passing through ocelli. Antennae reaching hardly beyond tegulae. Flagellum subcylindrical, clavate, nude beneath. Most joints of flagellum when viewed on their widest side appear a little broader than long, but joint 1 a little shorter than others and 2 and 3 slightly longer than thick. When viewed from another side the joints appear strongly nodose and crenulate on inner margin. Legs simple, rather slender. Joints 2 and 3 of hind tarsi slightly produced behind. Ventrite 4 with a small spicule-bearing tubercle near each apical corner. Ventrite 5 transverse at apex. Median area of ventrite 6 broad, dark colored, its margins a little arcuately expanding caudad, and continuous with a broad depressed apical lobe, which is about as long as wide, with apex broadly rounded and truncate in middle. Clypeus, except apical margins, densely punctured. Frons with fine, uniformly close punctures, about one puncture-width apart. Vertex more sparsely punctured, the punctures becoming very fine in area behind ocelli. Mesonotum finely and sparsely punctured, with a large area on posterior middle of scutum impunctate. Enclosure of propodeum subcrescentic, the striae rather close, those in middle closer, more irregular and forming a fine reticulation at apex. Tergites very finely, rather sparsely punctured. Pubescence white, moderately long and copious. All femora and hind tibiae beneath with long white hair. Abdomen with depressed hair, pure white and more conspicuous at base of tergites 2 to 6. Median area of ventrite 6 with very fine and short, erect hair, the apical lobe with a tuft of long white hair.

Female.—Length, about 6.5 mm. Similar to male. Black, with a hardly discernible greenish luster on frons. Flagellum pale ferruginous except at base. Depressed margin of tergites 1 to 5 yellow testaceous. Head about as long as wide. Mandibles slender, tapering, with a small inner tooth. Flagellum unusually short and clavate. Clypeus sparsely punctured. Frons, vertex and mesonotum with fine moderately close punctures. Striae of enclosure and punctures of abdomen about as in male. Pubescence about the same, slightly tinged with ochraceous on vertex and mesonotum. Hair of abdomen depressed, nearly uniformly distributed over disk of tergites 3 to 5, with slight indication of basal band on 2 and 3, the disk of 1 and 2 comparatively nude. Dense apical tuft of tergite 5 pale ferruginous. Scopal hairs of hind tibiae unusually sparse, as in other species of the *scintilla* group. Differs from *boregoensis*, female, in larger size, paler, more clavate flagellum, pubescence of abdomen more uniformly distributed, without a distinct band at base of tergites 2 to 4. From other black Californian species it is easily distinguished by the brown veins and stigma.

Described from 6 males (***holotype*** and ***paratypes***) collected at Edom, Riverside County, at flowers of *Oenothera clavaeformis*, March 14, 1937; 5 male paratypes on same day and same flower, 5 miles northwest of Edom (P. H. and P. F. Timberlake); 7 male paratypes, Edom, on *Oenothera*, March 14, 1937; and 7 male paratypes, female ***allotype***, Indio, on *Oenothera*, March 25, 1937 (R. M. and G. E. Bohart).

Dufourea (Halictoides) oenotherae, n. sp.

This species might be confused with *D. viridescens* (Cwfd.), as it agrees well with Crawford's description, but Mr. Michener informs me that the type of *viridescens* has the usual curled hairs on the under side of flagellum. In *oenotherae* the flagellum is nude and the species comes close to *D. boregoensis* (Mich.) but differs in having the head and mesonotum greenish, the apical lobe of sixth ventrite acute, and the antennae shorter and darker colored. The male of *D. scintilla* (Ckll.) is also similar but has the whole head, thorax and tergum of abdomen greenish, and the median area of sixth ventrite distinctly grooved, shining and produced at apex in to a short depressed blunt lobe, without a tuft of long hair.

Male.—Length, nearly 5.5 mm. (with abdomen extended). Black, the frons and vertex dark blue-green, the mesonotum greenish. Mandibles red at apex. Outer side of apical half of flagellum dark reddish brown. Depressed margin of tergites 1 to 6 pale translucent golden. Tarsi, especially small joints, slightly brownish. Spurs pale testaceous. Tegulae translucent brown, darker within. Wings slightly dusky (reddish) hyaline. Stigma and veins brown, the subcosta darker. Form

rather slender. Head a little wider than long, but not so transverse as in *boregoensis*. Inner orbits strongly converging below. Supraorbital line passing through ocelli. Antennae reaching hind margin of tegulae. Flagellum cylindrical, barely increasing in thickness distad, the joints distinctly nodose and crenulate, all about equal in length and about as long as wide. Legs rather slender, the small joints of hind tarsi barely produced behind. Ventrite 4 with a minute spicule near each apical corner. Ventrite 5 transverse at apex. Ventrite 6 with distinct, parallel-sided median area, produced at apex in to a depressed, broadly flame-shaped lobe, acute at apex. Clypeus closely punctured. Frons and vertex with fine strong punctures, about one puncture-width apart on the sides and a little sparser on middle of frons. Area behind ocelli very finely punctured. Punctures of mesonotum slightly finer and nearly as close as those of frons. Punctures of tergites very fine and sparse, becoming more numerous at base of tergites 2 to 5. Enclosure of propodeum short, crescentic, with fine, even, moderately close striae. Pubescence white, copious, dense as usual below antennae and long on under side of femora and hind tibiae. Apical lobe of ventrite 6 with a tuft of moderately long hair. Hair of abdomen depressed, most conspicuous at base of second and following tergites, where it is somewhat band-like.

Described from 1 male (*holotype*) collected at Tujunga Wash, Los Angeles County, at flowers of *Oenothera bistorta*, April 17, 1927 (Timberlake).

OYO-KONTYU

We have just received a request to exchange the ANNALS for the OYO-KONTYU which is a new journal published by the Nippon Society of Applied Entomology. The address is: Imperial Agricultural Experiment Station, Nisigahara, Takinogawa, Tokyo, Nippon. The Entomological Society of America has no library and makes no exchanges.

We have before us volume one, number 1, August, 1938. Except for translated English titles subbed under the Japanese titles and an index translated into English, the entire journal is in the Japanese idiograph. The arrangement is western, from left to right and with the lines of the text horizontal.

In courtesy to a new journal we assume that it is printed in Japanese because it will be used largely within Japan (and China and outlying islands in the process of absorption). Because a western language was not chosen it will be over ninety per cent useless to entomologists outside of Japan. We regret that western languages cannot be used for science, preferably French, German or English as these have had the lead. They are ample and are simple languages to learn. Japanese or Chinese is said to require about six times as much study in acquisition as does any one of the languages of Western Europe. The majority of Oriental scholars already use one or more of these simpler languages.—C. H. K.

A DISCUSSION OF THE EURYTOMA RHOIS COMPLEX WITH A DESCRIPTION OF A NEW SPECIES (EURYTOMIDAE)[1]

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The vast majority of the Eurytomidae are parasitic, but phytophagy appears in at least two of the tribes. The Isosomini are primarily addicted to various species of grasses while within the Eurytomini the relatively few phytophagous species show a more varied choice of plant hosts (host data, Gahan 1922 and Bugbee 1936). In the latter tribe some twelve or more species are recorded from seeds, among them *Eurytoma rhois* Crosby (1909) from the seeds of *Rhus typhina* L. (staghorn sumac). Since the original description appeared it has been mentioned only twice in the literature (Gahan 1922 and Bridwell 1923).

In the past three years seeds from two other species of Rhus (*R. glabra* L. and *R. copallina* L.) collected in the United States as well as a third species (*R. virens* Lindh.) from Mexico have yielded considerable material a study of which is reported here. One new species is described from Mexico and this is followed by a redescription of *Eurytoma rhois* to conform to the additional data gathered from a study of the new material and with it is given a section on the general biology of *rhois*.

Because the nature of the material is so complex and in the event that more material from a wider range may in the future somewhat alter the present picture as presented in the final discussion it has seemed best to consider the material from the United States under the one species *Eurytoma rhois* and designate it as the *E. rhois complex*. The new species from Mexico adds a second species to the complex.

[1]I wish to express gratitude to Dr. A. C. Kinsey for aid and encouragement in this study and to the Department of Zoology of Indiana University for allowing me laboratory space in which to work during the summer of 1938; also to Miss Lois Hertlein for technical work and to willing collectors whose names are mentioned in the succeeding pages.

Family Eurytomidae. Genus Eurytoma

Eurytoma compressa sp. n.

(Of the *Eurytoma rhois* complex)

(Figs. 1 and 3)

Female.—Length, 2–3 mm.; average, 2.5 mm.; body black, with exception of tip of ovipositor which may be infuscated cephalad of tip, under surface of scape in larger specimens, ring joint, trochanters, distal tips of fore-femur, distal and proximal tips of mid and hind-femur and tibia, fore-tibia and tarsi, reddish brown to lemon yellow; tarsal claws and pads black; sculpturing and distribution of white pile same as in *E. rhois*; abdomen from the side is elliptical rather than ovate as in *E. rhois* and averages in length about 1.7 times the length of the thorax; the eye is large and oval and the ratio of the eye to the head is of the order 1—2.

Male.—Length, 2.1–3 mm.; average, 2.5 mm.; this average would be greater in live specimens as they curl up when killed; body black; legs, except occasional infuscation on hind-tibia, yellowish brown; scape sometimes yellowish brown underneath; wing veins heavier and darker than in female.

This species is much like *E. rhois* in general appearance, color, sculpturing, etc., but differs in the female in the longer, elliptical, more laterally compressed abdomen (Figs. 1 and 2); the slightly larger eye (Figs. 3, 4 and 6), and average longer length. The males also are larger, averaging 2.5 mm. in length as compared to 1.9 mm. for *E. rhois* males. The differences in hosts and their distribution are also important.

Described from two females and four males collected by Dr. O. P. Breland on November 17, 1935. Labels read, C. Victoria, 21 W., Tamaulipas, Mexico. 10-17-35, Breland coll.

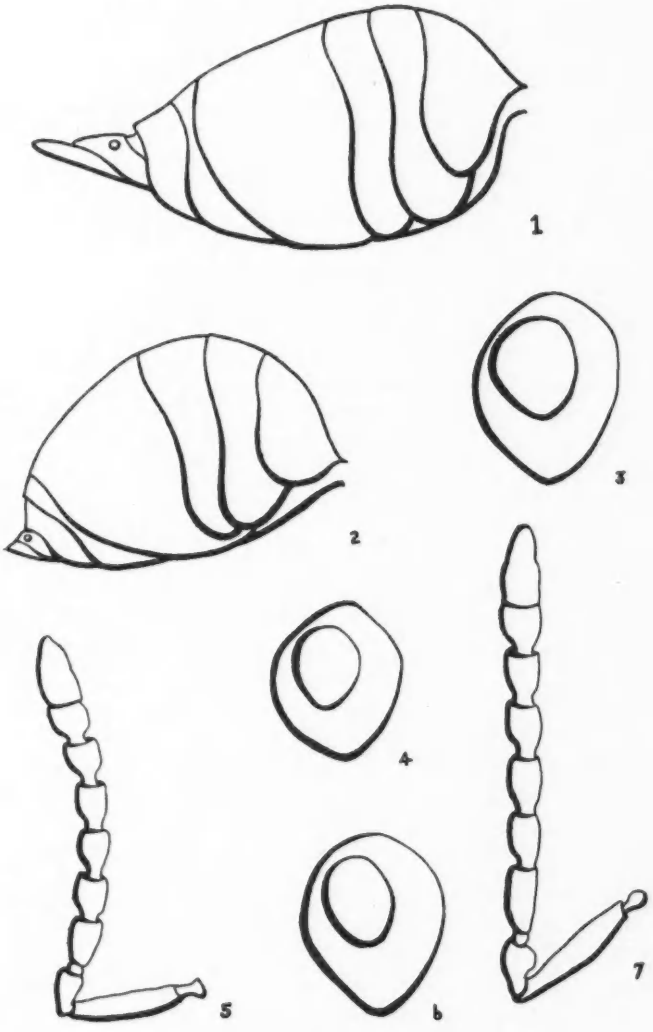
Host.—*Rhus virens.*

Range.—According to Barkley (1937) the host ranges from south-central Texas and southeastern New Mexico, south to Chihuahua and Nuevo Leon, Mexico. It seems likely that the wasp will occupy much the same range.

Type locality.—C. Victoria, 21 W., Tamaulipas, Mexico.

Types.—Two females and four males. *Holotype* female and paratype males and female: Bugbee collection. Paratype male and female to be deposited in the National Museum.

Emerged.—11-25-35.



EXPLANATION OF PLATE

(For drawings of abdomen, insects enlarged to 125 mm.; for antenna, to 175 mm.; for head, to 125 mm.)

Figure 1. Side view of abdomen of *Eurytoma compressa*. (Female.) 2. Side view of abdomen of *Eurytoma rhois*. (Female.) 3. Side view of head of *Eurytoma compressa*. (Female.) 4. Side view of head of *Eurytoma rhois*. (Female). 5. Antenna of *Eurytoma rhois*. (Female.) 6. Side view of head of *Eurytoma rhois*. (Female.) 7. Antenna of *Eurytoma rhois*. (Female.)

Eurytoma rhois Crosby

(Of the *Eurytoma rhois* complex)

(Figs. 2, 4, 5, 6 and 7)

Eurytoma rhois Crosby 1909, Canadian Ent. 41:52. Crosby, 1909, Bull. Cornell U. No. 265: 385–388. Gahan, 1922, Proc. Ent. Soc. Washington. 24: 33–58. Bridwell, 1923, Jl. Washington Acad. Sci. 13: 262.

Female.—Length, 1.5–3 mm.; average, 2.2 mm.; body, antenna and coxa black; ring joint, under surface of scape (sometimes), trochanters and mandibles yellowish brown; tips of ovipositor sheaths yellowish brown or with varying amounts of black infuscation; most often all femurs with yellowish brown tips and varying amounts of black infuscation medially; less often fore and mid-femurs all yellowish brown; fore and mid-tibias most often yellowish brown and less often with some black infuscation; hind-tibia usually with some infuscation; head, with exception of a small triangular shagreened area under eye surrounding a small pit, which may be absent in small specimens, and dorsal thorax, umbilicate punctate; lateral sides of prothorax shagreened with a median longitudinal depression; prepectus with a median depression cut across midway by an oblique ridge; mesopleurum with a shallow depression from base of coxa to beneath tegula, pitted, becoming ridges posteriorly; propodeum with or without a shallow median depression; basilly is a deep, longitudinal pit; sides of propodeum deeply pitted; surface of depression with raised horizontal and longitudinal ridges; between ridges surface is shagreened; abdomen smooth above but delicately shagreened laterally becoming more dense ventrally; from the side ovate in fresh specimens; head, thorax, with exception of sides of prothorax and mesothorax, last two segments of abdomen and hind-coxa covered with silvery white pile; antenna with first segment of the funicle longest; in some specimens remaining segments tend to become quadrate towards tip with last three grouped as a slightly enlarged club; in others the segments remain longer than wide and the last three although grouped together have the same diameter as the rest; average ratio of width of eye to head is 1—1.8; eyes oval in shape in larger specimens and elliptical in smaller specimens; wing veins usually straw yellow to reddish brown; stigmal club varies from a condition in which it is deeply rounded basilly to a flattened condition basilly; number of spines on the subcosta varies from 8–17 with an average of 10.

Male.—Length, 1.3–2.3 mm.; average, 1.9 mm.; body black; other color with much the same variation as in the female; exhibits the usual male secondary sexual characteristics typical of the genus Eurytoma.

The redescription is based on the published description, my own material, and two paratype females kindly loaned to me for study by Dr. J. C. Bradley of Cornell University. Paratype labels read, C. U. Exp. No. 795, Sub. 15 July, 08. Paratype, *Eurytoma rhois* Crosby.

Hosts.—*Rhus typhina, R. glabra* and *R. copallina.*

Range.—Central and eastern United States.

I have collections from the following localities. New York: Jamestown, 9 N. W. (Kohn coll.), Steamburg (Bugbee coll.). Pennsylvania: Erie, 8 W. and Meadville, 9 N. (Bugbee coll.). Ohio: Zanesville, 7 S., South Bloomingville, 4 E. and West Union, 6 N. (Bugbee coll.). Indiana: Winona Lake, Bloomington and Gosport, 3 S. (Bugbee coll.). Tennessee: Dickson, 7 W. (Bugbee coll.). Arkansas: Eldon, 4 E., Conway, 4 E., and Paris, 10 E. (Breland coll.). Sheridan, 4 N. (Bugbee coll.). Missouri: Wickes and Sullivan, 1 N. E. (Kinsey coll.). Louisiana: Jena, 3 E. (Bugbee coll.). Kansas: Toronto, 4 S. E., Emporia and Junction City, 3 S. (Bugbee coll.).

Localities mentioned in the literature.—Ithaca, N. Y., and East Lansing, Michigan (Crosby 1909) and Washington, D. C. (Bridwell 1923).

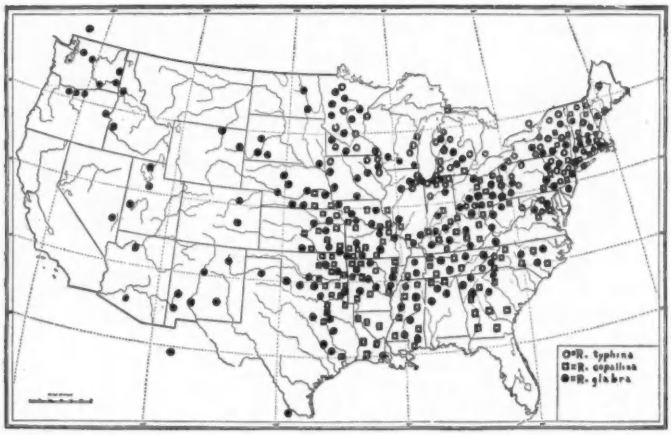
Type locality.—Ithaca, N. Y.

Types.—Cornell University, Department of Entomology.

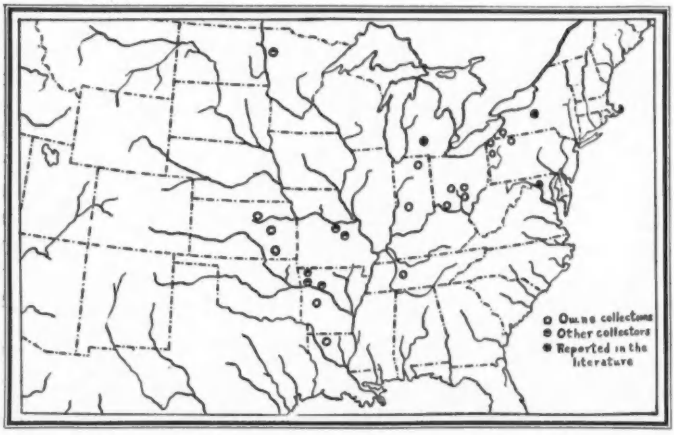
DISTRIBUTION OF THE SUMACS AND OF THE RHOIS COMPLEX

A word further may be said concerning the distribution of the *Eurytoma rhois* complex in the United States as well as the three host sumacs (*Rhus typhina*, *R. glabra* and *R. copallina*). A glance at map number 1 shows the distribution of the three species of the host. In the Northeast and along the southern border of the great lakes the three species are found together. At two different localities (Meadville, Pa., and South Bloomingville, Ohio) *Rhus glabra* and *R. typhina* have been found growing side by side. At still other points (Winona Lake, Indiana) they have been separated by not over a quarter of a mile. *R. copallina*, on the other hand, has never been collected beside either of the other two species but at some localities has been found nearby (Bloomington, Ind., and South Bloomingville, Ohio). Further attention to the map will show that *R. typhina* appears to be confined more or less to the northern tier of states. It apparently ranges southward only along the ridges of the Appalachian mountains into western North Carolina. *Rhus copallina*, on the other hand, although mingling with *R. typhina* in the Northeast, is more southern in the bulk of its range. Overlapping both *R. typhina* and *R. copallina* throughout their ranges is *R. glabra*, which in addition extends westward into Arizona and Nevada and northwestward to the Pacific coast and Canada.

Map number 2 represents the distribution of the phytophagous *E. rhois* complex. The distributional data are scanty when



Map No. 1. Distribution of *Rhus typhina*, *R. glabra* and *R. copallina*. This map represents a combination of my own collection records, data sent me on request taken from Herbarium sheets and the distribution maps appearing in the study of the Rhus genus by Barkley (1937).



Map No. II. Distribution of the *E. rhois* complex. This map is a combination of my own collections, material sent by other collectors and references from the literature.

compared with those for the hosts but more and more material is being added every year. So far the complex seems to extend

over the same distributional area as the three hosts. Only two references occur in the literature. Crosby (1909) recorded it from Ithaca, N. Y., and East Lansing, Mich., from *Rhus typhina* while Bridwell (1923) believed that material with which he worked from Washington, D. C., was the same as the material described by Crosby. He bred his material from *R. typhina* and *R. glabra*.

NOTES ON THE BIOLOGY OF E. RHOIS

Larva.—The larva, which is described by Crosby (1909, page 387), eats the heart out of the seeds. Just before pupation the hind intestine, which is loaded with waste material, accumulated during larval life, breaks through and emits a string of greyish brown, oblong pellets.

Pupa.—The pupal life, according to the material cut from the seeds and forced in the laboratory at room temperature, is from 10 to 12 days (chart number 1).

CHART No. I

COLOR CHANGES IN THE PUPA OF E. RHOIS

(Time given in average number of days)

Larva	Brown in Legs and Antenna	Orange Eye	Red Eye	Black on Thorax and Abdomen	All Black	Pupal Life
1	2	3	4	5	7	12 (died)
2	3	3	4	4	5	8
3	3	3	4	5	6	10
5	2	3	4	5	6	10
11	2	3	4	5	7	11
12	2	?	4	4	5	?
13	2	3	4	5	6	10
15	1	4	4	5	6	11
16	2	4	5	6	7	10
20	2	4	5	6	7	?
23	?	4	5	?	?	died
24	?	3	4	?	?	7
25[1]	3	?	6	6	?	12
Average	2.18	3.3	4.3	5	6.2	10.1

[1]Placed in the refrigerator for two days at 50 degrees C.

The appearance of a color pattern in the originally glistening white pupa follows a very orderly sequence. The first color is a brownish tinge in the legs and antennae about the second day. The eyes in three days assume an orange color turning to deep red by the fourth or fifth day. Black on the abdomen and thorax first appears on the fourth or fifth day and by the sixth or seventh day the whole body is completely black (chart number 1).

Two to three days before emergence, contractions of the legs and antennae can be observed through the transparent pupal skin which begins to wrinkle in places and draw away from the wasps body within. Finally the skin cracks open in the mid-dorsal line of the thorax and the adult emerges.

Emergence.—Emergence begins the last of May or the first week in June and runs through June and July. The greatest numbers occur from about the middle of June to the middle of July when many have been seen mating and ovipositing. By the last of July practically all the wasps have disappeared. The males are always the first to appear and the females appear in numbers later (chart number 2). The ratio of males to females seems to be about equal. The actual count running some 3019 males to 3615 females.

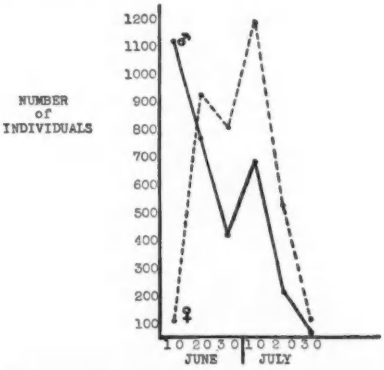


Chart 2. Emergence of males and females of *Eurytoma rhois*.

From observations made in the field and from experiences with bred material the actual emergence depends a good deal upon the nature of the season. Thus an early spring brings an earlier emergence and earlier flowering of the sumacs and a late spring delays emergence and flowering, as evidenced by the spring of 1938 when only a few females were found on July 10th and many fruits, at least on *R. typhina*, were just beginning to turn red. This correlates with the fact that in the laboratory, contrary to some other groups of parasitic Hymenoptera (e. g., Cynipidae, Kinsey MS.) these wasps can be forced at least after they have undergone one good cold spell. Cold weather slows up their development as pupa placed in a refrigerator at 50 degrees C. had their pupal days lengthened from 2–4 days (see chart number 1).

Considerable second year emergence has been obtained from both *Rhus typhina* and *R. glabra* seeds from such localities as Jamestown, N. Y., Meadville, Pa., South Bloomingville, Ohio, Toronto and Junction City, Kansas. This material has given a large number of females and only a half dozen males, all from the same locality (Jamestown, N. Y.). Bridwell (1923) found full-fed larvae in seeds of both *Rhus typhina* and

R. glabra in February, 1923, which were collected in the winter of 1921–22. He believes that adverse conditions, such as drouth and excessive temperatures, may cause larvae to remain dormant into the second year or even longer.

Upon emerging both males and females immediately crawl or fly upwards. The seeds from which they come may be on the ground or still hanging to the old seed clusters of the year before, which are below the new seed clusters. This appears to be a nice illustration of positive phototropism. They will also crawl quickly from the dark interior of a separating box into a glass jar affixed to the side of the separator.

The emerged wasps leave neat small holes in the seeds. Occasionally something interferes with their gnawing out, for apparently normal, dead wasps have been cut from seeds in which they have literally been buried alive.

Much time is spent after emergence in cleaning the whole body, legs and antenna. The adult specimens which were cut out of their seeds as larvae and forced to pupate in the laboratory spent from one to two days, in small vials to which they were consigned, attempting to gnaw their way through the glass. When a vial was inverted they went to work on the cork. The instinct within them to gnaw their way out of the seed after leaving the pupal skin was so strong that time had to be allowed for this to run its course before they would begin mating.

I have never observed in the field adult wasps taking nourishment. However, females confined in small vials have been observed drinking sweetened water. Small grayish spots on the side of the vial suggested excrement. One female who imbibed the nectar lived eighteen days while the usual length of life for those merely confined in vials without the water was on the average of six days.

Mating.—Mating occurs in the usual manner for the Chalcidoidea. The male mounts the back of the female and after much twiddling of the antenna and running nervously back and forth the male turns its abdomen ventrally and on one side or the other of that of the female and inserts its penis in the region of the hypopygium. This process may be repeated many times. Actual copulation holds for only a few brief seconds. The same female may be mounted by several different males and copulation completed. The female is not passive during the attempts of the male, and prevents success of the latter on many occasions. This same process holds for all the Eurytomidae in which mating has been witnessed so far.

Oviposition.—This is also typical of many of the Chalcidoidea. The female, after examining the location carefully with her antenna, bends the abdomen ventrally until the tips of the exposed ovipositor sheaths are placed over the point of entrance of the ovipositor. When the ovipositor is well placed the abdomen and sheathes are raised to a horizontal position again, leaving the naked ovipositor, which is now at right angles to the abdomen, supported anteriorly by the expanded, shield-like hypopygium. During this procedure she is raised high on her legs. With a sidewise motion of her abdomen the ovipositor is slowly worked into the seed and her body settles down between her legs. The whole process may take from five to ten minutes. Each female may oviposit in many differ-

ent seeds. The long haired seeds of *R. typhina* seem to offer some resistance and prevent a firm foothold so that the procedure may be somewhat prolonged.

DISCUSSION

During the three years that this study has been in progress it has become more and more apparent that before too definite conclusions can be stated much more material from the entire range of the complex must be collected and studied. Nevertheless certain indications of the nature of the problem have appeared by a study of the some seven thousand or more wasps at hand.

The knowledge of the so-called continental species and the contrast between such large groups and the smaller insular species have been studied critically by several workers. One such recent study is that made by Kinsey (1937) who interprets the two contrasting groups from an evolutionary standpoint. One of the most obvious and important differences between insular and continental species, as he points out, is the lack of any great isolating mechanisms in the latter. When this study was first attempted the fact that three separate species of hosts existed, in an area which lacked any great physiographic isolating features, suggested that host isolation might be one of the factors in species formation in this particular group. With this in mind a morphological study of the wasps bred from the three hosts was undertaken. The result was that in the characters investigated (wing venation, antennal characters, head and eye ratio, sculpturing, color, size, etc.) no outstanding, clear-cut correlations with host distribution have been detectable. This may not seem so strange when one considers the present day distribution of the hosts (see map number 1). Both *Rhus typhina* to the north and *R. copallina* to the south are overlapped by *R. glabra* and all three occur together in the northeast. Here then are three distinct hosts isolated in some other manner than geographical which, nevertheless, seem to form enough of a continuous medium to support a single species of wasp.

It is easy to observe that the wasps are not strong fliers but as they are small and light a comparatively light wind might carry them some distance. I believe, however, that they tend to remain and oviposit in the same stand of sumac from year to year with a minimum of wandering. That they do spread, either

under their own power or by some other means, is evidenced by the following. In northwestern New York state near my home is a field which was used by a farmer for many years for growing various crops. During that time no sumac was within a radius of up to one-half a mile. For the last fifteen years it has stood idle and among a flora of many species which have reclaimed it is a flourishing stand of staghorn sumac. With the stand has also appeared *Eurytoma rhois* and many have been collected for several years. This of course is within the range of *R. typhina*. At another time spikes of seeds from *R. typhina* which had been transplanted from its normal range into southern Indiana (Bloomington) as a young plant without seeds and grown there for several seasons yielded a small number of wasps. This was in a region in which both *R. glabra* and *R. copallina* occurred commonly throughout the county.

The nature of the distribution of the hosts in the past should be given some consideration. The rise and fall of civilizations has been known to effect the distribution of many plants and animals as well as other factors such as the breaking of the heredity string by the very upsetting of the distribution. The sumacs were probably at one time much more evenly spread over the countryside than today and thus formed a more continuous pathway for the spread of the associated wasps as well as local mutations which either became lost or spread rapidly throughout the population. With the increase in agriculture in this country much of the sumac has been grubbed out and the stands today are limited to fence rows, uncultivated tracts, stream and lake banks, etc. Thus what may have been once a more or less continuous range has been broken up into a discontinuous, patchwork distribution. Each small stand supports its wasp population which because of the increased distance between the stands of the hosts, form small breeding colonies with a minimum of transfer to nearby populations. The data suggest that this breaking up of the range has been done within what may be such a comparatively short time that only a few groups of large numbers and with more or less distinct limits have as yet made their appearance. Given time, however, the effect of the breaking up of the distributional area may yet lead to the appearance of more distinct groups. The following data may suggest that indications of this are already under way.

A further characteristic of wide ranging continental species is to show smaller or local divisions which differ slightly in

maybe one or two non-adaptive characters which may or may not grade imperceptably into the rest of the population. Indications of segregation in the *E. rhois* complex also appear. In studying the material it was noticed that wasps from Jamestown and Steamburg, N. Y., Erie, Pa., and Winona Lake, Ind., have longer antenna (ranging from .97 mm. to 1.20 mm. with an average of 1.10 mm.). Correlated with this is a longer scape and first antennal joint. Material from southern Arkansas, northern Louisiana and eastern Tennessee ranges from .86 mm. to 1.10 mm. with an average of .98 mm. and exhibits a slightly shorter scape and first joint while material from central Pennsylvania through southern Ohio, central Missouri and southeastern Kansas have the shortest antenna of all (ranging from .71 mm. to 1.23 mm. with an average of .92 mm.). Averages for the relation of the width of the eye to the width of the head suggest the same general division into three groups. Use of other characters, however, may still give a basis for a division into several groups that do not coincide with the above mentioned groups or with each other. Furthermore, although the averages may differ in many cases the same limits of variation will exist. The data seem to warrant the mention of these divisions only as indications of segregation.

At still other localities within the whole population, without respect to the three groups mentioned above, appear several smaller groups which suggest the "micrographic races" of Dobzhansky (1937, page 146). They are restricted to small local areas within the population. Thus material from South Bloomingville, Ohio, with respect to the length of the scape in both range (.16 mm. to .25 mm.) and average (.22 mm.) is less than for the general population which has an average of .25 mm. Again material from Jena, Louisiana, with respect to the ratio of the width of the eye to the head is less than the average for the whole population as well as the averages from each locality. Similar conditions exist for several other small colonies.

It might be expected that on the basis of a detailed genetical analysis that local races and even species might be separated out from the population with more or less distinct limits. However, the morphological data indicate such complete gradation and overlapping that considering the material anything more than a continental species, with an understanding that indications of local races and even smaller divisions exist, seems to be all that the data warrant at this time.

That this evidence of segregation within this large population may be a step towards ultimate speciation seems probable. Wright (1931 and 1932) argues that the division of a population into numerous, partially isolated colonies, is such a step. The indications of this subdivision in the *E. rhois* complex have been pointed out. With distance already acting in this group as a partial isolating factor the appearance of more potent isolating factors, such as chromosomal aberrations (Wright 1932), should finally appear and lead to the segregation of distinct species. This material may yet contribute to the question as to whether species may arise by the subdivision of the parental range or by the migration to a new unoccupied area.

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PACIFIC SCIENCE CONGRESS

The Sixth Pacific Science Congress will be held in San Francisco and vicinity between the dates of July 24 and August 12, 1939, under the general auspices of the National Research Council. The Entomological Society of America has been invited to participate in the Congress by the appointment of representatives on this occasion. With this end in view, all members of the Society who are planning to attend the Congress are requested to communicate with the undersigned as soon as possible.

E. M. WALKER,
President of the Entomological Society of America.

THE BIOLOGY OF CELL SURFACE by ERNEST EVERETT JUST, pages i-xi and 1–392, 42 figs., 6x9 inches, 1939. Published by P. BLAKISTON'S SON & CO., INC., 1012 Walnut St., Philadelphia. Price $5.50.

More and more, biologists are realizing that one of the very critical areas in living matter is the cell surface. To use a very inept figure of speech: with living matter it is the neck of the bottle. All supplies have to pass into the living cell through the surface and all wastes and energies must pass out through the same area. The two flows must not conflict. The cell surface is the region of transition or of tension between the organic interior and the inorganic exterior. Thus it is an area of greatest physiological flexibility and to exist at all is in a continuous state of readjustment between the living interior and the non-living exterior.

Furthermore, the cell surface is in a constant state of antagonism with the growth of the contents of the cell. Being a spherical surface it grows in extent as the square of the radius while the contents which it covers grow in volume as the cube of the radius. As growth advances the contents that need food through the surface and which have to evacuate wastes through the same membrane make more and more demands on cell surface activity. Nearly all phases of organic evolution are partial solutions, and usually only partial, of this continuously existent conflict between the rapacious contents of the organic cell and its geometrically limited surface. The activities and struggles of this limited cell surface are the subject matter of the present volume.

Professor Just, since 1912, has studied such phenomena as parthenogenesis, cleavage, and other cell activities connected especially with activities of the cell surface. The work has been carried on at the Berlin-Dahlem Kaiser-Wilhelm-Institut für Biologie, at the Naples Station and at Woods Hole.

The subjects treated in the present work are: 1. Introduction; 2. Life and Experiment; 3. Protoplasmic System; 4. The Ectoplasm; 5. General Properties of the Ectoplasm; 6. Water; 7. The Fertilization-Process; 8. The Fertilization-Reaction; 9. Parthenogenesis; 10. Cell-Division; 11. Cleavage and Differentiation; 12. Chromosomes and Ectoplasm; 13. Bibliography. Index to Authors. Index to Subjects.

The author amasses and arranges his evidence to impress the reader with the intense activity of the cell surface, a term which he uses interchangeably with ectoplasm, the outer layer of the cell. After reviewing the various activities which appear to be centered in the ectoplasm he concludes (chapter 11): "Ectoplasmic behavior is thus the direct and so far the only visible manifestation of the cause of the differentiation of development which takes place during cleavage." The argument is excellent, if we forget the chromosomes.

Chapter 12 reviews the argument of chromosome control *versus* ectoplasmic control. He concludes: "To me the conclusion seems inescapable: ectoplasmic behavior determines the cytoplasmic reactions that lie at the basis of neuclear activity." Chapter 13, "Ectoplasm and Evolution" and chapter 14, "Conclusion," we will leave for the reader.

While we feel that Professor Just has done a lot of ignoring in confining his argument to the evidence for ectoplasmic control of all activities, we recognize that organic forces are largely surface energies. We recognize that the surface of the cell, between two different environments, is a zone of tension or stress, and that surface cytoplasm (ectoplasm) is active and versatile, in the otherwise naked animel cell, or it would not preserve its existence. "To him that hath shall be given." Perhaps the very resourceful ectoplasm does exercise much control over cell activities even up to cleavage, differentiation and some of the processes of evolution.

A volume of this type has high value in reviewing those neglected fields of evidence which do not agree with current popular scientific theory. It is an excellent review by a ranking authority of the everyday business activities of the cell surface. Much of the data and many of the reasoned interpretations are directly from Professor Just's own research in this field. In fact the volume is almost a summary of his life work.

We wish to compliment Blakiston on the quality of the press work and binding. Both are above the average.—C. H. K.

A REVISION OF THE NEARCTIC MELECTINAE
(Hymenoptera, Anthophoridae)

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The bees discussed below have been placed by some authors in the Nomadidae, treated by others either as a separate family, the Melectidae, or, more rarely, as a subfamily of the Anthophoridae, the Melectinae. Of these alternatives the latter seems most in accord with our present knowledge of the group. The relationship of the melectine bees with the Nomadidae would appear to be remote since the two groups differ markedly in wing structure. In the Melectinae the anterior wing sculpture is highly differentiated with a broad band of minute papillae along the apical margin and the wing hairs reduced to a very few areas, primarily along the anterior margin (see figs. 1–4). The Nomadidae, however, have retained a more primitive wing structure, with the papillae and hairs more or less evenly distributed. Likewise, the nervellus of the posterior wings of the melectines is very oblique, frequently sinuate or curved, and nearly attains the fork of the cubital vein (fig. 5), but is straight and more or less right-angled in the nomadids. These characters suggest an anthophoroid origin for the melectine bees, possibly a panurgoid origin for the nomadids.

The present paper makes known the results of a preliminary study of this group. Many of the described North American Melectinae are at present known only by the types or in a single sex. This is unfortunately true of some of the more critical forms, and the status of several so-called species and subspecies will not be satisfactorily determined until a longer series of specimens from many more localities has been accumulated and something of the biology is known. It is hoped that the present paper, by calling attention to the fragmentary state of our present knowledge, may stimulate the study of this interesting group of bees.

[1]The writer is indebted to Dr. T. D. A. Cockerell, Mr. P. H. Timberlake, Mr. C. D. Michener, and Messrs. G. E. and R. M. Bohart for the loan of specimens from their private collections, and to Mr. E. P. Van Duzee of the California Academy of Sciences, Mr. E. T. Cresson, Jr., of the Academy of Natural Sciences of Philadelphia, Prof. R. H. Beamer of the University of Kansas, and Dr. J. McDunnough of the Canada Department of Agriculture, for the privilege of studying types and other material in their care. The line drawings were kindly made by Mr. E. S. Ross.

DISTRIBUTION[2]

The subfamily Melectinae is distributed throughout the world, although none of the genera as here restricted occupies all of that area. The African and Indo-Malasian regions are dominated by the genus *Crocisa*. The Palearctic region possesses the genus *Melecta* and a limited number of *Crocisa* which have penetrated from the south. In South America the group is well represented by several genera, very inadequately understood, including *Rathymus* and *Acanthopus*. The most diverse of the known melectine faunas occurs in North America, where we have at least four genera, *Melecta*, *Brachymelecta*, *Zacosmia*, and *Ericrocis*.

Melecta, the most generalized group of the subfamliy, is confined, in North America, to the area west of the Mississippi River. The species of the typical subgenus are chiefly montane, and are most abundant in the Coast Range, Cascade, Sierra Nevada, and Rocky Mountains. The subgenus *Melectomorpha* is best represented in the barren grounds of the Great Basin and Great Plains region, although it also occurs along the Pacific coast. *Xeromelecta* is confined to the southwestern deserts, and *Melectomimus* to the sand dune areas of coastal California. The fact that the genus has been broken up into four subgenera in the Nearctic region as compared to two such groups in Europe and Asia might be interpreted as an indication that *Melecta* arose on this continent. Such an explanation would have to account for the absence of the genus from eastern North America whereas in the Palearctic Region it occurs from Atlantic to Pacific. It is hard to believe that a period of time great enough to allow so much diversity within the Nearctic fauna would have been insufficient to permit the group to spread across the continent.[3] A possible, but not entirely satis-

[2]In the present paper the writer has departed slightly from the customary method in listing locality records. It was felt that greater conciseness and increased clarity could be obtained by arranging the known distribution of species in summary form, without reference to date of capture, collector, etc. Many of the records are taken from the literature, particularly from the voluminous works of Cockerell, and no attempt has been made to acknowledge the source of these individually. Of the new records, the majority are from the collections of Mr. P. H. Timberlake, Dr. E. C. Van Dyke (in the California Academy of Sciences), Mr. G. E. and Dr. R. M. Bohart, Mr. C. D. Michener, and the writer. Where the new records (whether pertaining to locality, host, flower, or date of capture) are of particular significance, they are acknowledged separately in the text.

[3]The fossil record reveals little as to the length of time the melectines have been in North America. *Protomelecta brevipennis* Ckll., described from the Miocene (Oligocene?) shales of Lake Florissant, is apparently not closely related to the genera under consideration. From the description, its affinities would appear to be with the Eucerinae.

factory explanation, might be found in the fact that the hosts of *Melecta*, the bees of the genus *Anthophora*, are neither as abundant in individuals nor species in eastern North America as they are in the West.

Brachymelecta appears to be endemic to western North America. Little is known of the distribution of the genus since the type species is recorded only from "Nevada." Like *Melecta*, to which it is closely related, it was probably derived from northern stock.

Zacosmia is also a North American endemic and is confined to the Great Basin area and the desert and semi-desert regions of the Southwest. The genus is isolated taxonomically, and it cannot be stated with certainty whether it is of northern or southern origin.

Ericrocis is a truly American genus. It is confined to the desert regions of southwestern United States and northern Mexico (including Lower California), and like many of the plants and animals of this area its nearest relatives are to be found in Chile. It is undoubtedly a group of southern origin.

PHYLOGENY

The Melectinae present a number of problems which are difficult to account for phylogenetically. Disregarding those characters which are clearly attributable to their parasitic habits, there appears to be but a single important character shared by all of the genera, the very oblique nervellus of the posterior wings. Although this character is approached by many other anthophoroid bees, it is rarely attained to the degree observable in the Melectinae, and its universal presence in the latter group is difficult to account for on the basis of mere convergence. However, when a comparison is made between individual genera of Melectinae with existing genera of non-parasitic anthophoroids, certain striking resemblances are observable which indicate that the group may be polyphyletic in origin. Several genera suggest a derivation from *Anthophora* (Anthophorinae), others a relationship with *Epicharis* and *Centris* (Centrinae). If these apparent relationships are actual, it will be necessary to discard the present grouping and incorporate the genera in different subfamilies. However, it is the object of the present study merely to point out some of these similarities and to await the results of further exploration, particularly in South America, before making a decision in the matter.

Among the North American genera *Melecta* is the least differentiated morphologically and is thus the most recent in origin. (This apparent anomaly is characteristic of parasitic bees since the direction of their specialization is away from their parent stock, and if this stock exhibits primitive characters, the most "primitive" of the parasitic derivatives are usually the most recent.) *Melecta* shares many important structural characters with its host genus, *Anthophora*, differing primarily in the shorter marginal cell of the anterior wing, more oblique nervellus of the posterior wing, and those structures, the presence or absence of which, are associated with a parasitic mode of life. The males have no pygidial field, a character common to most *Anthophora*, and the mouth parts are also similar. Cockerell and Atkins (1902), after a study of the mouth structures, concluded that *Melecta* was derived from the anthophoroid series but not from *Anthophora*, but Grütte (1935) has shown that the mouth parts may be readily homologized. Within the genus *Melecta*, the typical subgenus possesses, like *Anthophora*, the primitive number of segments in the maxillary palpi (six) and presents the most *Anthophora*-like appearance. *Melectomorpha*, on the other hand, is the most specialized subgenus, with the maxillary palpi reduced to four segments. This group has lost the facies of *Anthophora* and adopted the habitus of the "typical" parasitic bees, with contrasting colors and short pubescence.

The genus *Brachymelecta* is closely related to *Melecta* and may have been derived from it rather than independently from *Anthophora*. It differs from *Melecta* chiefly in the reduced wing venation, mouth parts, and in the type of vestiture.

Zacosmia is the most highly specialized of our melectine genera. The maxillary palpi are reduced to a single segment and the antennae of the males are greatly thickened. The pygidial field, however, is present in both sexes, an occurrence rare in the Anthophorinae. If it was derived from *Anthophora*, it may have arisen from some species like *A. curta* Prov. In the latter species, however, the male pygidial area is unlike that of *Zacosmia* and may well have been developed secondarily.

Ericrocis is an isolated type with bifid intermediate tibial spurs and without a definite pygidial field in either sex. This combination of characters does not suggest a derivation from *Anthophora*. Perhaps the genus is an offshoot from some group like *Epicharis*, which Grütte considers to be ancestral to *Acan-*

thopus and *Rathymus*. The isolation of *Ericrocis* has been emphasized by Cockerell and Atkins (1902) who proposed a separate subfamily for the genus and suggested a possible relationship to *Centris*.

KEY TO THE GENERA OF NEARCTIC MELECTINAE

1. Marginal cell short, not attenuated apically, not extending beyond apex of last submarginal cell; intermediate tibiae spinose at apex, tibial spur slender, apex neither forked nor spined; sixth abdominal tergite of female with a well defined pygidial field.....2

   Marginal cell elongate, attenuated apically, extending well beyond apex of last (third) submarginal cell; intermediate tibiae with a broad apical tooth, tibial spur broad, apex bifid or trispinose; sixth abdominal tergite of female without a definite pygidial field; maxillary palpi two-segmented, **Ericrocis**

2 Anterior wings with three submarginal cells; pubescence of abdomen erect or with patches of depressed hairs.....3

   Anterior wings with two submarginal cells; pubescence of abdomen dense, depressed, unbroken; flagellum of male antennae filiform, outer segments but little broader than long; seventh abdominal tergite of male without a pygidial field; small species, less than 8 mm. in length.....**Brachymelecta**

3. Maxillary palpi with four, five, or six segments; flagellum of male antennae with intermediate segments at most only twice as broad as long; seventh abdominal tergite of male without a pygidial field; larger species, more than 10 mm. in length.....**Melecta**

   Maxillary palpi with one free segment; flagellum of male antennae with intermediate segments greatly thickened, several times as broad as long; seventh abdominal tergite of male with a well defined pygidial field; smaller species, less than 8 mm. in length.....**Zacosmia**

Genus **Melecta** Latreille

Melecta LATREILLE, 1802, Hist. nat. Fourmis, p. 427.

Moderate-sized, robust, frequently densely pubescent. *Head* narrower than thorax; antennae moderately short, not attaining tegulae; outer flagellar segments rarely transverse in the male; mandibles with the inner margin simple, uni-, or bidentate; maxillary palpi with four, five, or six free segments. *Thorax* robust; mesoscutellum more or less bilobed, the lobes frequently armed with a tooth or spine; intermediate and posterior legs moderately stout, elongate, pubescent, intermediate tibiae spinose at apex, tibial spur slender, apex not forked or toothed; anterior wings elongate, distinctly surpassing apex of abdomen, with three submarginal cells, marginal cell short, apex rounded or truncate, not attenuated, not extending beyond apex of third submarginal cell. *Abdomen* truncate at base, without a transverse carina; sixth tergite of female with a well-defined pygidial field; seventh tergite of male without a pygidial field.

Genotype: *Apis punctata* Fabricius (Latreille designation, 1810).

This genus is distinct among the Nearctic Melectinae by its large size, robust form, four-to-six-segmented maxillary palpi,

and simple first tergite of the abdomen. The known subgenera may be recognized as follows:

TABLE OF SUBGENERA OF THE GENUS MELECTA

1. Mesoscutellum biconvex, posterior margin feebly projecting over metanotum; maxillary palpi distinctly shorter than basal segment of labial palpi..2
   Mesoscutellum large, plane, posterior margin strongly produced, overlapping metanotum, lateral angles toothed; maxillary palpi long, slender, subequal in length to basal segment of labial palpi; mandibles with inner margin unidentate; dorsal pubescence of thorax short; marginal cell rounded at apex. (Asia).....**Pseudomelecta**
2. Dorsal lobes of mesoscutellum armed with a tooth or spine; wings lightly infuscated or mottled with brownish.....3
   Dorsal lobes of mesoscutellum rounded, unarmed; wings very dark blackish; thoracic pubescence short, dense, erect; maxillary palpi slender; inner ramus of claws of intermediate and posterior tarsi short, lobe-like; marginal cell rounded at apex; outer flagellar segments of male antennae distinctly transverse, the flagellum swollen.....**Xeromelecta**
3. Mandibles with inner margin edentate or unidentate; lobes of mesoscutellum acute or armed with a dorsal spine; thoracic pubescence long, erect, dense; first abdominal tergite never spotted with appressed pubescence, usually clothed with long, erect, pale hairs; marginal cell rounded at apex; inner ramus of tarsal claws usually long, slender; outer flagellar segments of male antennae at most a little wider than long.....4
   Mandibles with inner margin bidentate, lobes of mesoscutellum with a short posterior tooth; thoracic pubescence short, appressed, patch-like; first abdominal tergite with spots of appressed pubescence, never clothed with erect pale hairs; marginal cell truncate at apex; inner ramus of tarsal claw short, lobe-like; outer flagellar segments of male antennae distinctly transverse, the flagellum swollen.....**Melectomorpha**
4. Mandibles with inner margin distinctly unidentate; maxillary palpi five-segmented or with a short sixth segment; facial line at most subequal to transfacial line; mesoscutellar lobes acute or armed with a stout spine, never as long as surrounding pubescence; first abdominal tergite clothed with long, erect, pale hairs; pygidial area broad at base, slender apically, apex parallel-sided or acute, not covering dorsal surface of sixth tergite, **Melecta** s. str.
   Mandibles with inner margin edentate or with a very feeble inner tooth; maxillary palpi six-segmented, the ultimate segment nearly as long as the penultimate; facial line distinctly longer than transfacial line; mesoscutellar lobes armed with a slender, curved spine as long as surrounding pubescence; first abdominal tergite without any long, erect, pale hairs; pygidial area of female large, triangular, covering dorsal surface of sixth tergite.....**Melectomimus**

Subgenus Melecta s. str.

Melecta LATREILLE, 1802, Hist. nat. Fourmis, 427; LATREILLE, 1802, Hist. nat. Crust. Ins., 3: 376; WALCKENAER, 1802, Faun. Paris, 2: 119; LATREILLE, 1809, Gen. Crust. Ins. 4: 171; LATREILLE, 1810, Cons. Gener., 439; CURTIS, 1826, Brit. Ent., Hym., 125; BLANCHARD, 1840, Hist. nat. Ins., 3: 410; WESTWOOD, 1840, Intro. Mod. Class. Ins. (suppl.), 2: 85; LEPELETIER, 1841, Hist. nat. Ins., Hym., 2: 439; SHUCKARI, 1866, British Bees, 255; TASCHENBERG, 1883, Berl. Ent. Zeitschr., 27: 74; FRIESE, 1895, Bienen Europa's, 1: 153; BINGHAM, 1897, Faun. Brit. India, Hym., 1: 515; SCHMIEDEKNECHT, 1907, Hym. Mitteleur., 143; ALFKEN, 1912, Ber. Westpr., Bot.-Zool. Ver., 34: 15; MORICE AND DURANT, 1915, Trans. Ent. Soc. Lond., 1915: 424; FRIESE, 1925, Ins. Mitteleur., 1: 108; GRUTTE, 1935, Arch. f. Naturg., 4: 480–488; ALFKEN, 1937, Konowia, 16: 175.

Symmorpha KLUG, 1807, Mag. f. Ins., 6: 227.

Bombomelecta PATTON, 1879, Bull. U. S. Geol. Surv., 5: 370; CRESSON, 1887, Trans. Am. Ent. Soc. (suppl.), 1887: 128; FOX, 1893, Ent. News, 4: 144; ASHMEAD, 1899, Trans. Am. Ent. Soc., 26: 66; FOWLER, 1902, Rept. Agr. Exp. Sta. Univ. Calif., 1898-1901: 326; COCKERELL AND ATKINS, 1902, Ann. Mag. Nat. Hist., (7) 10: 46; COCKERELL, 1910, Ann. Mag. Nat. Hist. (8) 5: 27; COCKERELL, 1910, Univ. Colo. Studies, 7: 183, 192; COCKERELL, 1928, Univ. Colo. Studies, 16: 104.

Maxillary palpi shorter than basal segment of labial palpi, five-segmented or with a short sixth segment; mandibles with inner margin unidentate; antennae of male with outer flagellar segments at most a little wider than long; facial line at most subequal to transfacial line. Dorsum of thorax clothed with long, erect, dense pubsecence; mesoscutellum biconvex, posterior margin only feebly projecting over metanotum, dorsal lobes acute or armed with a stout spine which is never as long as the surrounding pubescence; wings lightly infuscated, marginal cell rounded at apex (fig. 1); inner ramus of claws of intermediate and posterior tarsi usually long, slender (fig. 9). Abdomen with first tergite clothed with long, erect, pale hairs, never spotted with appressed pubescence; fasciae of following tergites, when present, formed of appressed plumose hairs; pygidial field of female narrowed apically, not covering entire dorsal surface of sixth tergite, apex narrowly rounded or acute.

Type: Apis punctata Fabricius.

The members of this subgenus are abundant in the Palearctic region and in western North America. The American forms were given the name *Bombomelecta* by Patton, who misunderstood the true *Melecta*, but they are apparently congeneric with the European species typified by *M. punctata* (Fab.). The American species may be separated as follows:

KEY TO THE NEARCTIC SPECIES OF MELECTA S. STR.

FEMALES

1. Pygidial field of sixth abdominal tergite broad at base, narrowed and more or less parallel-sided apically, apex rounded, surface slightly convex or with a vague longitudinal carina.....2
   Pygidial field of sixth abdominal tergite cuneiform, flat; first flagellar segment of antennae distinctly longer than second; pubescence of occiput, dorsum of thorax, and first abdominal tergite ochraceous; wings fuscous. 15 mm. Nevada.....**thoracica**
2. Mesoscutellar lobes acute or armed with a short, obtuse spine, very much shorter than, and usually hidden by, surrounding pubescence.....3
   Mesoscutellar lobes armed with a long, stout spine, but little shorter than surrounding pubescence; first flagellar segment of antennae nearly as long as the two following together; vertex with a triangular impunctate area in front of median ocellus. 13 mm. California.....**sierrae**
3. First flagellar segment of antennae longer than second segment; apical margin of abdominal tergites two to four distinctly punctured.....4
   First flagellar segment of antennae shorter than second segment; apical margin of abdominal tergites two to four minutely tessellate but impunctate; pubescence of dorsum of thorax and first abdominal tergite sparse, grayish, not concealing surface; abdominal tergites two and three with a faint, transverse, lateral, patch of grayish pubescence. 9–11 mm. California (Mojave Desert).....**bohartorum**

4. Mesoscutum without a transverse band of black hairs between the wing bases, dorsal pubescence of thorax concolorous, whitish or fulvous; supra-clypeal area clothed entirely with black pubescence; abdominal tergites without pale pubescent fasciae. 11–16 mm. Pacific coast to Nebraska.....**pacifica**

Mesoscutum with a transverse band of thin black pubescence bwteeen the wing bases, remaining dorsal pubescence of thorax whitish to fulvo-ochraceous; supra-clypeal area with some white pubescence; abdominal tergites usually with pale pubescent fasciae. 9–15 mm. Pacific coast to New Mexico.....**separata**

MALES

1. Lobes of mesoscutellum acute or armed with a short, obtuse spine, very much shorter than, and usually hidden by, the scutellar pubescence.....2

Lobes of mesoscutellum armed with a long, stout spine, but little shorter than the scutellar pubescence; first flagellar segment of antennae nearly as long as the two following together; vertex with an impunctate, triangular area in front of median ocellus. 12 mm. California.....**sierrae**

2. Intermediate tibiae without a dense pad of white pubescence on outer face; clypeal pubescence dark, black or brownish.....3

Intermediate tibiae with a dense pad of short, white, felt-like pubescence on outer face; clypeal pubescence long, dense, white; dorsal thoracic pubescence thinner on disk of scutum, frequently with some black hairs. 11–15 mm. New Mexico to Pacific coast.....**separata**

3. Pubescence of lower face grayish brown; mesosternum, mesepisterna, and legs clothed with grayish pubescence; abdominal tergites two to five densely clothed with grayish brown, heavily plumose, hairs. 14.5 mm. Colorado.....**semifulva**

Pubescence of lower face black, sometimes white on middle of clypeus; mesosternum, mesepisterna, and legs clothed with black pubescence; abdominal tergites two to five clothed with black hairs. 9–16 mm. Western North America.....**pacifica**

Melecta (Melecta) thoracica Cresson

thoracica CRESSON, 1875, Wheeler Exp., Zool., 5: 726, pl. 33, f. 5, ♀; VIERECK, 1903, Trans. Am. Ent. Soc., 29: 179, ♀ (*Bombomelecta*).

Female.—"Deep black; occiput, thorax above, and first abdominal segment above, clothed with a dense ochraceous pubescence; wings fuscous."—Cresson's original description. "Pygidial area cuneiform, flat. First joint of flagellum distinctly longer than second; first abdominal segment with pale pubescence."—Viereck (l. c.)

Type locality: Eastern Nevada.[4]

This species is unknown to me. I would consider that it was the same as *M. sierrae* (described below) were it not that Cresson described the wings as "fuscous" and Viereck the pygidial area as "cuneiform, flat." In *sierrae* the wings are what Cresson called in other species "faintly dusky," and the pygidium is quite similar to that of *M. pacifica*. Patton (1880, Bull. U. S. Geol. Surv., 5: 370) nominally proposed the genus *Bombomelecta* for *M. thoracica*, but his remarks leave considerable doubt as to whether or not he actually knew that species.

[4]Cresson (1916, Mem. Am. Ent. Soc., 1: 132) gives the type locality as Colorado.

Apparently the specimens which he had at hand represented *M. pacifica* Cresson, a species which Patton considered synonymous with *thoracica*. The same may have been true of Ashmead (1890, Bull. Colo. Biol. Assn., 1: 30), who recorded *thoracica* from Colorado, for although the latter state has been subjected to rather intensive bee collecting in recent years, the Cresson species has not been recognized again.

Melecta (Melecta) sierrae Linsley, new species

Female.—Black, pubescence of vertex, dorsum of thorax, and first abdominal tergite grayish-white, remaining pubescence black. *Head* with frons and vertex moderately densely pubescent; vertex closely punctured, opaque, except for a triangular area in front of median ocellus which is impunctate, shining; antennae black, scape clothed with moderately long, erect, black hairs, pedicel transverse, pubescence very short, flagellum with first segment nearly as long as the two following together; clypeus moderately shining, closely and moderately coarsely punctured, densely clothed with long, black hairs at base, becoming glabrous apically. *Thorax* densely pubescent; mesoscutum coarsely, closely punctate, interspaces shining, surface partially obscured by the long, erect, pale hairs; mesoscutellum with dorsal lobes each armed with a long, stout spine, a little shorter than but not hidden by the scutellar hairs; mesepisterna opaque, closely, but less coarsely punctured than scutum; mesosternum coarsley, closely punctured, interspaces shining; wings pale brownish; legs moderately densely pubescent, posterior femora slightly rufopiceous. *Propodeum* with enclosure nearly glabrous, otherwise densely clothed with long, erect, black pubescence. *Abdomen* shining, finely, but not closely puctured; first tergite densely clothed with long, erect, pale hairs; tergites two to five without any pale pubescent fasciae, inconspicuously clothed with recumbent black hairs; pygidial area of sixth tergite broad at base, sides incurved, apex liguliform, narrowly rounded. Length: 13 mm.

Male.—Clypeus densely clothed with long, erect, black pubescence; intermediate tibiae with a small, thin patch of white hairs at middle of outer face; seventh abdominal tergite subglabrous. Length: 12 mm.

Holotype female (No. 4771 Calif. Acad. Sci. Ent.), from Lake Tahoe, California, June 16, 1933, E. G. Linsley, collector, and *allotype* male (in Timberlake collection), from Big Bear Valley, San Bernardino Mts., Calif., May 19, 1933, at flowers of dandelion (C. M. Dammers). A female specimen in the Timberlake collection from Lind, Washington (F. R. Cole) differs in having shorter scutellar spines and pale pubescence on the clypeus and outer face of the intermediate tibiae. This may represent an undescribed species.

In color and form *M. sierrae* superficially resembles *pacifica* Cresson, but may be readily distinguished in both sexes by the

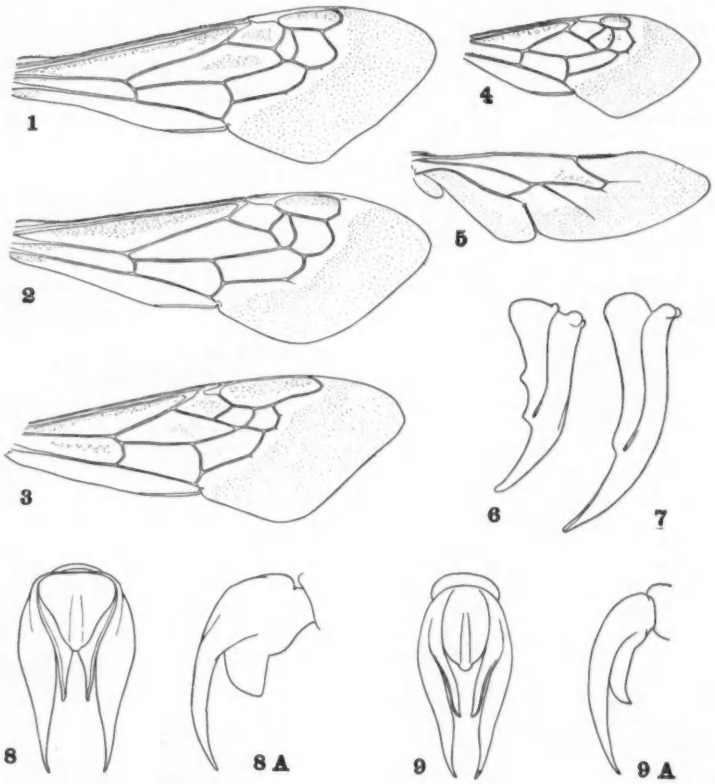

Fig. 1. Anterior wing of *Melecta* (*Melecta*) *callura* Ckll.
Fig. 2. Anterior wing of *Melecta* (*Melectimorpha*) *californica* Cress.
Fig. 3. Anterior wing of *Ericrocis arizonensis* Baker, ♂.
Fig. 4. Anterior wing of *Zacosmia maculata* Cress.
Fig. 5. Posterior wing of *Ericrocis arizonensis* Baker.
Fig. 6. Left mandible of *Melecta* (*Melectimorpha*) *californica* Cress., ♀.
Fig. 7. Left mandible of *Melecta* (*Melectimimus*) *edwardsi* Cress., ♀.
Fig. 8. Posterior tarsal claws of *Melecta* (*Melectimorpha*) *californica* Cress., ♀.
Fig. 9. Posterior tarsal claws of *Melecta* (*Melecta*) *callura* Ckll., ♀.

long, stout spines of the scutellum, the triangular, impunctate, pre-ocellar area, and the proportions of the first three segments of the flagellum (in *pacifica* the first segment is barely longer than the second, in *sierrae* it is nearly as long as the two following together. It may possibly be related to *thoracica* Cresson but apparently differs in the shape of the pygidium (in *thoracica* the pygidium is "cuneiform, flat") and the paler wings (in *thoracica* the wings are "fuscous").

Melecta (Melecta) pacifica Cresson

pacifica CRESSON, 1878, Trans. Am. Ent. Soc., 7: 91, ♂.

Female.—Black, pubsecence of vertex, dorsum of thorax, and first abdominal tergite grayish-white to fulvous. *Head* with frons and vertex densely clothed with long, erect, black hairs intermixed with paler pubescence above and between antennal bases; surface anterior to median ocellus closely but irregular punctured; antennae slender, scape moderately densely clothed with black hairs a little longer than diameter of flagellum, pedicel very transverse, flagellum glabrous, first segment as long as or longer than second; clypeus nearly glabrous, shining, moderately coarsely, closely punctured at base where the punctures are distinct and nearly adjoining, a little more widely separated toward apex where the punctures are oblique and shallower anteriorly; labrum coarsely, irregularly punctured with a smooth area on each side at base. *Thorax* densely pubescent; mesoscutum coarsely, closely punctured, the surface obscured by the long, erect hairs; tegulae black, finely, sparsely punctured; mesoscutellum densely pubescent, the hairs obscuring the dorsal lobes which are armed with a short spine or tooth; mesepisterna coarsely, closely punctured, clothed with coarse, black hairs which do not obscure the surface; wings light brownish; legs clothed with short, recumbent hairs with a bluish caste, intermixed with longer, scattered, suberect, black hairs, basitarsi clothed beneath with brownish pubescence. *Propodeum* densely clothed with long black hairs except enclosure which is coarsely, closely, punctured, sparsely pubescent. *Abdomen* finely punctured; first tergite densely clothed with long, erect, ochreous to fulvous hairs, tergites two to five without pubescent fasciae, apical margins of tergites two to four shining, finely but distinctly punctured; pygidial area liguliform, broad at base, sides incurved, apex narrowly rounded, surface a little convex, not covering all of exposed portion of sixth tergite. Length: 11–16 mm.

Male.—Similar to female but with clypeus densely clothed with long, black pubescence, or with white pubescence at middle. Length: 9–16 mm.

This species is widely distributed throughout western North America. Two subspecies may be recognized as follows:

1. Pubescence of dorsum of thorax and first abdominal tergite grayish-white or ochraceous. Rocky Mountains and Pacific Coast.....**pacifica** s. str.
   Pubescence of dorsum of thorax and first abdominal tergite fulvous. Great Basin Region.....**fulvida**

Melecta pacifica pacifica Cresson

pacifica CRESSON, 1878, Trans. Am. Ent. Soc., 7: 91, ♀ (nec ♂); CRESSON, 1887, Trans. Am. Ent. Soc., Suppl. Vol., 298 (*Bombomelecta thoracica* var.); VIERECK, 1903, Trans. Am. Ent. Soc., 29: 179, ♀ ♂ (*Bombomelecta*); VIERECK, 1906, Can. Ent., 38: 278, ♀ ♂ (*Bombomelecta*); SWENK, 1907, Ent. News, 18: 298 (*Bombomelecta*); COCKERELL, 1928, Univ. Colo. Studies, 16: 104 (*Bombomelecta*).

thoracica, PATTON, 1880, Bull. U. S. Geol. Surv., 5: 370 (*Bombomelecta*); ? ASHMEAD, 1890, Bull. Colo. Biol. Assn., 1: 30 (*Bombomelecta*); FOWLER, 1901, Univ. Calif. Exp. Sta., 2: 326 (*Bombomelecta*); BRAY, 1917, Pom. Jour. Ent. Zool., 9: 94 (*Bombomelecta*).

thornica BRAY, 1917, Pom. Jour. Ent. Zool., 9: 94 (*Bombomelecta*).

Pubescence of vertex, occiput, dorsum of thorax, and first abdominal tergite grayish-white or ochraceous, rarely fulvochraceous.

Type: No. 2270, Acad. Nat. Sci. Phila.

Type locality: California.

Range: Mountains of western North America primarily in the Transition Zone. Definite localities include the following: CALIFORNIA: Trinity Co. (Coffee Creek), Alameda Co. (Berkeley and Oakland Hills), Monterey Co. (Paraiso Springs), Los Angeles Co. (Palmdale, Mint Canyon, Claremont, San Gabriel Mts.), San Bernardino Co. (San Bernardino Mts., Strawberry Flats, San Bernardino, Deep Creek), Riverside Co. (Riverside, Perris), Kern Co. (Mojave), Tulare Co. (Greenhorn Mtn.), Fresno Co. (Towle), Mariposa Co. (El Portal), Placer Co. (Lake Tahoe); OREGON: Prairie; NEVADA: no locality; COLORADO: Teller Co. (Florissant), Sedgwick Co. (Julesburg); NEBRASKA: Sioux Co. (Warbonnet Cn.), Thomas Co. (Halsey), Platte Co. (Monroe Cn.); WYOMING: Laramie; BRITISH COLUMBIA: Salmon Arm, Vernon, Penticton.

Flight period: May–June.

Flower records: *Amsinckia, Lantana, Astragalus.*

Host: Unknown.

The flower records are from the Timberlake collection.

Melecta pacifica fulvida Cresson

fulvida CRESSON, 1878, Trans. Am. Ent. Soc., 7: 204, ♀; CRESSON, 1887, Trans. Am. Ent. Soc., Suppl. Vol., p. 198 (*Bombomelecta thoracica* var.); COCKERELL, 1895, Psyche (suppl.) 7: 11 (*Bombomelecta thoracica* var.); COCKERELL, 1898, Bull. Sci. Lab. Den. Univ., 11: 61 (*Bombomelecta thoracica* var.); COCKERELL, 1898, Bull. Univ. New Mexico, 1: 61 (*Bombomelecta thoracica* var.); VIERECK, 1903, Trans. Am. Ent. Soc., 29: 179, ♀ (*Bombomelecta*); VIERECK, 1905, Can. Ent., 37: 278, ♀ (*Bombomelecta*); COCKERELL, 1928, Univ. Colo. Studies, 16: 104 (*Bombomelecta*); LINSLEY, 1938, Ent. News, 49: 160 (*Bombomelecta*).

Pubescence of vertex, occiput, dorsum of thorax, and first abdominal tergite bright fulvous.

Type: No. 2289, Acad. Nat. Sci. Phila.

Type locality: Nevada.

Range: Mountains of Great Basin area, primarily in the upper Sonoran and lower Transition Zones, ranging from 1000 to 3000 feet elevation in the north and between 5000 and 9000 feet in the south. Definite localities include the following: ALBERTA: Medicine Hat; BRITISH COLUMBIA: Chilcotin, Salmon Arm, Vernon, Penticton; WASHINGTON: Whitman Co. (Pullman); OREGON: Umatilla Co. (Meachim), Union Co. (Elgin), Baker Co. (Melhorn's Mill), Malheur Co., Harney Co. (Stein Mts.), Lake Co. (Warner Mts.), Klammath Co. (Fremont Nat. Forest); CALIFORNIA: Modoc Co. (Hackamore), Nevada Co. (Truckee), Mono Co. (West Walker River), Mojave Desert; NEVADA: No locality; ARIZONA: Coconino Co. (Grand Canyon), COLORADO: Boulder Co. (Boulder), Jefferson Co. (Morrison), Montezuma Co. (Mesa Verde Park), Rio Grande Co. (South Fork); NEW MEXICO: Dona Ana Co. (Mesilla Valley).

Flight period: April-May (lower altitudes), May–June (higher altitudes).

Flower records: *Pentstemon*, *Lycium*, *Pulsatilla*, and *Senecio*.

Host: Unknown.

Melecta (Melecta) semifulva (Cockerell)

semifulva COCKERELL, 1921, Ann. Mag. Nat. Hist. (9) 7: 212, ♂ (*Bombomelecta*); COCKERELL, 1928, Univ. Colo. Studies, 16: 104 (*Bombomelecta*).

Black, clothed mostly with grayish-brown pubescence except on dorsum of thorax and first abdominal tergite which are clothed with fulvous hairs. *Head* densely covered with moderately coarse, long, erect pubescence, that of lower face, cheeks, and underside of head sooty-grayish; antennae with first flagellar segment a little longer than second; clypeus prominent, projecting, surface shining and moderately coarsely, closely punctured, apical margin polished. *Thorax* densely pubescent above; mesoscutum coarsely and very closely punctured, surface obscured by the fulvous pubescence; tegulae piceous, shining, finely punctured; mesoscutellar lobes acute but not spinose; metanotum and mesepisterna coarsely, closely punctured, clothed with grayish-brown hair broadly tipped with black; wings more or less uniformly pale brownish; legs clothed with grayish hair, black on inner side of tarsi. *Abdomen* shining; pubescence of first tergite long, dense, suberect, tergites two to six moderately densely clothed with depressed, heavily plumose, grayish-brown hair, sparsely intermixed with suberect black hairs which are more numerous posteriorly; abdominal fasciae lacking. Length 14.5 mm., anterior wing 10.5 mm.

Type: No. 4673, Calif. Acad. Sci., Ent.

Type locality: Boulder, Colorado.

This species, known to the writer only by the holotype, is related to *M. pacifica* Cresson, differing primarily in the color of the erect hairs of the face, cheeks, underside of head, legs, and sternum, and by the presence of appressed, densely plumose, grayish-brown hairs on abdominal segments two to six. Nothing is known of its distribution, hosts, or flower preference.

Melecta (Melecta) bohartorum Linsley, new species

Female.—Black; pubescence thinner than usual for genus, mostly black except supra-clypeal area, occiput, dorsum of thorax, first abdominal tergite, and lateral patches of tergites two and three, which are clothed with grayish-white hairs. *Head* with face moderately densely clothed with long, erect hair, grayish above and between antennal bases; antennae with first flagellar segment little longer than second; clypeus shining, moderately coarsely, closely punctured, densely pubescent; mandibles moderately long, slender; labrum coarsely, irregularly punctured, surface concave, sparsely clothed with scattered, erect, black hairs. *Thorax* thinly pubescent, particularly on disc of mesoscutum, where the hairs are very sparse and do not obscure the surface; mesoscutum coarsely, closely punctured, the punctures mostly adjoining except at middle of disk where some punctures are separated by about one puncture width; tegulae black, sparsely and moderately finely punctured; mesoscutellum coarsely, closely punctured, sparsely pubescent except along margins, mesoscutellar lobes each armed with a very feeble spine; mesepisterna opaque, coarsely, closely punctured, clothed with black pubescence which does not hide the surface; wings light brownish; legs clothed with suberect, black hairs intermixed with longer, erect hairs of the same color; apex of anterior femora with a tuft of long, white hairs. *Propodeum* coarsely, closely punctured, moderately densely clothed with long, black hairs except enclosure, where the hairs are sparse, scattered. *Abdomen* shining, finely but not closely punctured, apical margin of tergites two to four minutely tesselate, almost impunctate; first tergite sparsely clothed at base with pale hairs; tergites two and three with a thin, transverse, lateral patch of densely plumose white hairs; pygidial field broad at base, sides incurved, apex narrowly rounded. Length 12 mm., anterior wing 10.3 mm.

Holotype: Female (No. 4772 Calif. Acad. Sci., Ent.), collected near Mojave, California, April 10, 1936, by G. E. and R. M. Bohart. *Paratypes:* One female with same data as type (Bohart collection), one female from Adelanto, Calif., May 11, 1935, C. M. Dammers collector (Timberlake collection), and one female from the Providence Mountains, San Bernardino Co., Calif., April 15, 1938, Don Meadows collector (Los Angeles Museum).

M. bohartorum may be readily recognized by the sparse pubescence of the thoracic dorsum and the faint abdominal

fasciae. From the *separata-callura* group it may be further separated by the short first segment of the flagellum and absence, in the female, of a transverse black band between the wing bases. From *pacifica* it differs in the fasciate abdomen with the apical margin of tergites two to four impunctate, the presence of white hairs in the supraclypeal area, etc. The Adelanto paratype has much white pubescence on the posterior femora but otherwise agrees with the holotype.

Melecta (Melecta) separata Cresson

separata Cresson, 1878, Trans. Am. Ent. Soc., 7: 204, ♀.

Female.—Black, clothed mostly with black pubescence except supraclypeal area, occiput, dorsum of thorax, and first abdominal tergite, which are clothed with long, grayish to fulvochraceous hairs. *Head* with face moderately densely clothed with long, erect pubescence; antennae with first flagellar segment longer than second; clypeus shining, coarsely, closely, but irregularly punctured, apical half subglabrous; labrum coarsely, irregularly punctured, with a few scattered, erect, coarse, black hairs. *Thorax* densely clothed above with long, pale pubescence except for a thin, transverse band of black hairs between the tegulae; mesoscutum coarsely, closely punctured, the punctures nearly adjoining; tegulae black, shining, finely, sparsely punctured; mesoscutellum densely pubescent, dorsal lobes each acute or armed with a short spine, obscured by hair; wings lightly infuscated; legs clothed with moderate pubescence, very long on underside of intermediate and posterior femora. *Propodeum* densely clothed with long, black pubescence except enclosure, where the hairs are scattered, sparse, and do not obscure the surface. *Abdomen* dull, often with a bluish caste, moderately finely, closely punctured, tergites without an apical impunctate margin; first tergite densely clothed with long, erect, pale hairs, heavily plumose, remaining tergites with or without white fasciae, clothed with depressed brownish or bluish-black hairs intermixed with scattered, longer, suberect, coarse, black setae; pygidial field broad at base, suddenly narrowed, long and parallel-sided apically, apex narrowly rounded. Length: 9–15 mm.

Male.—Clypeus densely clothed with long, white hairs; scutum without a distinct transverse dark band between the wings bases, discal hairs thinner, with scattered blackish hairs intermixed; anterior femora with a tuft of white hairs at apex behind; outer face of middle tibiae with a dense pad of white, felt-like pubescence; seventh abdominal tergite densely clothed with recumbent brownish pubescence. Length: 11–15 mm.

This species is characterized by having the first flagellar segment longer than the second in both sexes, the mesonotum of the female with a black band between the wing bases, and the intermediate tibiae of the male with a dense, white pad of felt-like pubescence on the outer face. The abdomen, except in

the typical subspecies, is usually maculate with lateral patches of depressed white hairs.

The following forms at present appear to represent subspecies of *M. separata* Cresson. Since two of these are known only by the unique types, it is possible that when more material is available, it will be necessary to revise their status.

KEY TO THE SUBSPECIES OF MELECTA SEPARATA CRESSON

FEMALES

1. Abdomen with pale pubescent fasciae....2
   Abdomen without pale pubescent fasciae; dorsal thoracic pubescence, except transverse black band, whitish or ochraceous; pubescence of legs entirely black. 12–13 mm. Nevada to Utah....**separata** s. str.
2. Intermediate and posterior legs clothed with black pubescence; lateral white patch of second abdominal tergite, if present, small, inconspicuous....3
   Intermediate and posterior legs with patches of white pubescence; lateral white patch of second abdominal tergite large, broad, conspicuous. 10–11 mm. Arizona....**arizonica**
3. Dorsal pubescence of thorax fulvochraceous. 12 mm. So. California..**mojavensis**
   Dorsal pubescence of thorax white or ochraceous. 11–13 mm. Pacific coast to Utah....**callura**

MALES

1. Abdomen with pale pubescent fasciae....2
   Abdomen without pale pubescent fasciae; cheeks and abdominal sternites four and five without any pale hairs. 13–14 mm. Nevada to Utah, **separata** s. str.
2. Cheeks clothed entirely with black pubescence....3
   Cheeks clothed mostly with white pubescence; abdominal tergites two to four with pale fasciae. 13 mm. New Mexico....**alfredi**
3. Pubescence of dorsum of thorax and first abdominal tergite white or ochraceous; abdominal tergites two to six or three to six fasciate; fourth and fifth abdominal sternites clothed with pale pubescence....4
   Pubescence of dorsum of thorax and first abdominal tergite fulvous; abdominal tergites two to five fasciate; fourth and fifth abdominal sternites without any pale pubescence. 14 mm. Colorado....**johnsoni**
4. Mesepisterna clothed almost entirely with white hairs; smaller 12–13 mm. So. California....**mojavensis**
   Only the anterior half of mesepisterna clothed with white hairs; larger 14–16 mm. Pacific coast to Utah....**callura**

Melecta separata separata Cresson

separata CRESSON, 1878, Trans. Am. Ent. Soc., 7: 204, ♀; VIERECK, 1903, Trans. Am. Ent. Soc., 29: 179, ♀ (*Bombolecta*).

Female.—Facial pubescence black except above and between antennal bases where it is mostly whitish. Legs clothed entirely with black pubescence. Abdomen without any pale pubescent fasciae on tergites two to six.

Male.—Pubescence of cheeks and sides of face black. Intermediate and posterior femora, and posterior tibiae clothed entirely with black pubescence; intermediate and posterior tarsi with white hairs intermixed. Abdomen non-fasciate; fourth and fifth sternites clothed with black pubescence.

Type: No. 2287, Acad. Nat. Sci. Phila., ♀.

Type locality: Nevada.

Range: Nevada and Utah. Definite localities: UTAH: Salt Lake Co. (Salt Lake City), Weber Co. (Huntsville).

Flight period: May.

Flower records: None.

Host: Unknown.

The above characters are drawn from two specimens captured at Salt Lake City, Utah, May 14 and 15, 1913, by P. H. Timberlake, who very kindly loaned them to the writer. A single female has also been studied from Huntsville, Utah, May 24, 1937, presented to the writer by D. D. Jensen.

Melecta separata callura (Cockerell)

(Pl.I, fig. 1, 9)

callura COCKERELL, 1926, Pan-Pac. Ent., 3: 58, ♂ (*Bombomelecta*).

separata, FOWLER, 1901, Rept. Agr. Exp. Sta. Univ. Calif. 1898–1901: 326 (*Bombomelecta*).

maculata VIERECK (nec. Cresson), 1903, Trans. Am. Ent. Soc., 29: 181, ♀ (*Bombomelecta*); VIERECK, 1906, Can. Ent., 38: 278, ♀. (*Bombomelecta*); COCKERELL, 1916, Pom. Jour. Ent. Zool., 8: 60. (*Bombomelecta*); LINSLEY, 1938, Ent. News, 49: 160 (*Bombomelecta*).

Female.—Facial pubescence black except above and between antennal bases where it is whitish. Legs clothed entirely with black pubescence. Abdomen with white pubescent fasciae on tergites two to four or three and four, the fasciae dense but variable in size. Length: 9–15 mm.

Male.—Pubescence of cheeks and sides of face black. Notal pubescence whitish. Intermediate and posterior femora clothed with black hair, posterior tibiae and intermediate and posterior tarsi with much whitish pubescence intermixed. Abdomen with dense, white, pubescent fasciae on tergites two to six, or three to six; fourth and fifth sternites clothed with white hairs. Length: 9–11 mm.

Type: No. 2396 Calif. Acad. Sci., Ent., ♂.

Type locality: Mill Valley, California.

Range: Pacific coast of North America, primarily in the Upper Sonoran and Transition Zones. Definite localities include: CALIFORNIA: Marin Co. (Mill Valley), Contra Costa Co. (Mt. Diablo), Alameda Co. (Oakland, Berkeley), Santa Clara Co. (San Jose, Palo Alto), San Mateo Co. (Ocean View), Monterey Co. (Stone Cn.), Fresno Co. (Coalinga), Tulare Co. (Tulare, Lindsay), Calaveras Co. (Mokelumne Hill), Kern Co. (Mojave), Los Angeles Co. (Los Angeles, Claremont, Mint Canyon, Palmdale), Riverside Co. (San Jacinto Mts., Gavilan, Riverside), San Bernardino Co. (Providence Mts.); OREGON:

Gilliam Co. (Condon), Lake Co., Klammath Co. (Fremont Nat. Forest); WASHINGTON: Whitman Co. (Walla Walla); BRITISH COLUMBIA: Vancouver Island, Victoria, Royal Oak; UTAH: Salt Lake Co. (Salt Lake City), Weber Co. (Huntsville).

Flight period: February to July.

Flower records: *Brassica, Amsinckia, Medicago, Lantana, Eriogonum.*

Host: ? *Anthophora edwardsii* Cresson.

This is the commonest subspecies on the Pacific coast. The males are large, with conspicuous lateral white patches on tergites two to six, although the fascia on tergite two is sometimes lacking. In the female the spots are smaller and occur on segments two to four or three and four. It commonly occurs with *Anthophora edwardsii* Cresson, a species on which it may possibly be parasitic. The Riverside and San Bernardino County localities and most of the flower records are from the collections of P. H. Timberlake and C. M. Dammers.

Melecta separata maculata Viereck (nec Cresson), described from Salt Lake City, was based on a female with a dot of white appressed pubescence on each side of abdominal tergites three and four. A second Utah example is also before the writer from Huntsville, May 18 (D. D. Jensen). Since typical *separata* also occurs at both Salt Lake City and Huntsville, it is possible that *maculata* Viereck is a mere variety of the Cresson species, although on the basis of the limited material known at present it cannot be distinguished from some females of *callura* Cockerell. In fact, the second (Oregon) specimen associated by Viereck with his Utah type is undoubtedly a female of *callura* which is common in Oregon.

Melecta separata mojavensis Linsley, new subspecies

Female.—Facial pubsecence black except above and between antennal bases where it is mostly fulvochraceous. Dorsal pubescence of thorax fulvochraceous. Legs clothed entirely with black pubescence. Abdomen with a lateral patch of ochraceous pubescence on tergites three and four. Length: 12 mm.

Male.—Pubescence of cheeks and sides of face black. Dorsal pubescence of thorax whitish; mesepisterna clothed almost entirely with white pubescence. Intermediate and posterior tibiae with some white hairs intermixed with the black pubescence. Abdominal tergites two to six with a lateral patch of white pubescence, that of tergite two indistinct; fourth and fifth sternites clothed with white pubescence.

Holotype, female, (No. 4773 Calif. Acad. Sci., Ent.) and *allotype*, male, (No. 4774 Calif. Acad. Sci., Ent.), from Mojave,

CALIFORNIA, April 10, 1936, collected by G. E. and R. M. Bohart. *Paratypes*, two females (in the collection of the writer) collected at Saugus, Calif., April 17, 1936, by J. L. Moyer.

This subspecies appears most closely related to *M. separata callura* Ckll., but differs in the fulvochraceous thoracic and facial pubescence of the female and the white-clothed mesepisterna of the males. It has thus far been found only on the Mojave Desert and adjacent areas.

Melecta separata alfredi (Cockerell)

alfredi COCKERELL, 1895, Psyche (Suppl.), 7: 11, ♂ (*Bombomelecta*); COCKERELL, 1898, Bull. Sci. Lab. Den. Univ., 11: 61, ♂ (*Bombomelecta*); COCKERELL, 1898, Bull. Univ. New Mex., 1: 61, ♂ (*Bombomelecta*); VIERECK, 1903, Trans. Am. Ent. Soc., 29: 179, ♂ (*Bombomelecta*).

Male.—Face, cheeks, and occiput densely clothed with long white hairs, mixed with black on cheeks beneath. Wings smoky-hyaline, the apical margin broadly smoky. Abdomen black, first four tergites with a transversely elongate patch of dirty-white pubescence on each side, these patches becoming successively smaller from the first. Length: 13 mm.

Type locality: Las Cruces, NEW MEXICO.

M. separata alfredi is at present known only by the type in the United States National Museum, Washington, D. C. Its distinctive features appear to be the white pubescent cheeks and arrangement of the abdominal fasciae.

Melecta separata arizonica (Cockerell)

arizonica COCKERELL, 1902, Can. Ent., 34: 267, ♀ (*Bombomelecta*); VIERECK, 1903, Trans. Am. Ent. Soc., 29: 179, ♀ (*Bombomelecta*); COCKERELL, 1907, Ann. Mag. Nat. Hist., (7) 19: 539, ♂ (*Bombomelecta*).

Female.—Upper half of face clothed with long, white hairs. Intermediate and posterior tibiae with patches or rings of white pubescence. Abdomen with lateral white pubescent fasciae on tergites two to five, those of second tergite notched posteriorly, nearly divided. Length: 10–11 mm.

Type locality: Tempe, Arizona.

Range: Southern Arizona. Definite localities: ARIZONA: Maricopa Co. (Tempe, Buckeye), Pima Co. (Tucson).

Flight period: March–April.

Flower records: *Sphaeralcea*, *Lycium*.

Host: *Anthophora forbesi* Cockerell.

A single example of this subspecies, a female from Buckeye, Arizona, on *Lycium torreyi*, March 28, 1934 (Timberlake), has been seen by the writer. Cockerell (1907: 539) records the

male but gives no characters other than the small size (12 mm.) which might be used to distinguish it from the other maculate subspecies.

Melecta separata johnsoni (Cockerell)

johnsoni COCKERELL, 1905, Ent. News, 16: 270, ♂ (*Bombomelecta*); COCKERELL, 1928, Univ. Colo. Studies, 16: 104, ♂ (*Bombomelecta*).

Male.—Pubescence of cheeks and sides of face black, that of frons and vertex whitish. Dorsal pubescence of thorax fulvous. Intermediate femora and posterior femora and tibiae clothed entirely with black pubescence, intermediate and posterior tarsi with a few white hairs. Abdomen with a lateral fulvochraceous patch on tergites two to five; fourth and fifth sternites clothed with black hairs. Length: 14 mm.

Type: No. 4667, Calif. Acad. Sci., Ent., ♂.

Type locality: Ft. Collins, COLORADO.

Flight period: May.

Flower records: *Astragalus.*

Host: ? *Anthophora montana* Cresson.

The only known specimen of this subspecies appears to be the type, which bears the information that it was taken at *Astragalus* on the hogback west of Ft. Collins, Colorado, May 26, 1905.

M. separata johnsoni may be distinguished by the fulvous notal pubescence and absence of pale hairs from the fourth and fifth abdominal sternites.

Melectomimus Linsley, new subgenus

Maxillary palpi shorter than basal segment of labial palpi, six-segmented, the ultimate segment nearly as long as the penultimate; mandibles long, slender, inner margin simple (♂) simple or very feebly dentate (♀) (fig. 7); antennae of male with outer segments of flagellum at most a little wider than long; facial line distinctly longer than transfacial line. Dorsum of thorax clothed with long, erect, dense pubescence; mesoscutellum biconvex, posterior margin scarcely projecting over metanotum, dorsal lobes each armed with a long, slender, curved spine which is as long as the surrounding hairs; wings lightly infuscated, marginal cell rounded at apex; inner ramus of claws of intermediate and posterior tarsi slender. Abdomen with first and following tergites non-fasciate and without any long, erect, pale hairs; pygidial field of female very large, triangular, flat or slightly concave, covering dorsal surface of sixth tergite.

Type: Melecta edwardsii Cresson.

This subgenus is proposed for a species which differs from all of the other members of the group in having the mandibles simple in the male, simple or feebly dentate in the female, an

elongate face, long, slender, curved spines on the mesoscutellum, no erect, pale hairs on the first abdominal tergite, and a large, triangular, pygidial field in the female.

Melecta (Melectomimus) edwardsii Cresson

(Pl. I, fig. 7)

edwardsii Cresson, 1878, Trans. Am. Ent. Soc., 7: 92, ♂; Patton, 1879, Bull. U. S. Geol. Surv., 5: 370 (*Pseudomelecta*); Fowler, 1902, Rept. Univ. Calif. Exp. Sta., 1898–1901; 326 (*Bombomelecta*); Viereck, 1903, Trans. Am. Ent. Soc., 29: 179, ♂, (*Bombomelecta*); Cockerell, 1904, Bull. So. Calif. Acad. Sci., 3: 160 (*Bombomelecta*); Cockerell, 1925, Pan-Pac. Ent., 1: 180 (*Bombomelecta*); Cockerell, 1937, Am. Mus. Nov., 948: 6 (*Bombomelecta*); Linsley, 1938, Ent. News, 49: 161, ♂ ♀ (*Bombomelecta*).

zygos Viereck, 1903, Trans. Am. Ent. Soc., 29: 179, ♀ (*Bombomelecta*).

Female.—Black, clothed with black pubescence except occiput and dorsum of thorax which are clothed with long, erect, whitish or ochraceous hairs. Head with face moderately densely clothed with coarse, erect hairs; antennae with first flagellar segment subequal in length to second segment; clypeus shining, irregularly, coarsely punctured, apical margin highly polished, impunctate; mandibles long and slender; labrum with surface concave, coarsely, irregularly punctured, interspaces smooth, shining. *Thorax* densely pubescent above; mesoscutum coarsely, very closely punctured, the punctures nearly adjoining, surface hidden by the dense pubescence; tegulae black, shining, finely punctured; mesepisterna coarsely, closely punctured, clothed with coarse, black hairs which do not obscure the surface; wings light brownish; legs clothed with short, fine, recumbent hairs which appear bluish when viewed from the base, and with scattered, long, erect, black hairs intermixed, these latter longer and denser on underside of intermediate tibiae; posterior basitarsi slender, at most only one-third as broad as apex of tibiae. *Propodeum* coarsely, closely punctured and moderately densely clothed with long, erect, black hairs except enclosure, which is irregularly and a little less coarsely punctured, subglabrous. *Abdomen* dullish with a bluish caste; tergites two to five minutely tesselate, finely but distinctly punctured, the surface clothed with short, fine, depressed, bluish micro-pubescence intermixed with scattered, longer, coarse, suberect, black hairs; first tergite with a few, scattered, erect black hairs; pygidial field large, triangular, covering exposed portion of sixth tergite, sides straight, apex rounded, surface flat or slightly concave. Length: 13—14 mm.

Male.—Antennae with first flagellar segment shorter than second; mesepisterna densely clothed with long, erect, pale hairs similar to those of dorsum of thorax; seventh abdominal tergite densely clothed with fine, short, recumbent, pale brownish pubescence, apex narrow, very feebly emarginate. Length: 13–14 mm.

Type locality: California.

Range: Sandy regions of central and southern California, primarily in the Upper Sonoran Life Zone at elevation of less than 3000 feet. Definite localities include the following: Cali-

FORNIA: Sonoma Co., Marin Co., Contra Costa Co., (Antioch), Alameda Co. (Oakland, Berkeley), San Francisco Co. (San Francisco), San Mateo Co., (Ocean View), Santa Clara Co. (Palo Alto), San Luis Obispo Co. (Pismo), Los Angeles Co. (Los Angeles), Riverside Co. (Morongo, Riverside, the Gavilan), and San Diego Co. (San Diego, Coronado Beach, Del Mar).

Flight period: March and April.

Flower records: *Amsinckia, Brassica.*

Host: ? *Emphoropsis* sp.

Little is known of the habits of this species. Mr. Timberlake has twice taken it at flowers of *Amsinckia intermedia* in Riverside Co., Calif. On one occasion the writer observed several females exploring the nests of *Emphoropsis* sp. at Antioch, Calif. Thus far there have been no verified records of a species of *Melecta* parasitizing any bee genus but *Anthophora.*

As has been previously pointed out (Linsley, 1938: 16), *Bombomelecta zygos* Viereck is the female of *edwardsii* Cresson.

Xeromelecta Linsley, new subgenus

Maxillary palpi slender, shorter than basal segment of labial palpi; mandibles with inner margin unidentate; antennae of male with outer flagellar segments very strongly transverse. Dorsum of thorax clothed with short, dense, erect pubescent; mesoscutellum biconvex, posterior margin only feebly projecting over metanotum, dorsal lobes unarmed; wings very dark, nearly black, marginal cell rounded at apex; inner claw of intermediate and posterior tarsi short, lobe-like. Abdomen with first tergite non-fasciate, without a dense pubescence of long, erect hairs; abdominal fasciae, when present, formed of fine, appressed, plumose hairs.

Type: Bombomelecta larreae Cockerell.

This subgenus is based on an anomalous species combining characters of *Melecta* s. str. and *Melectomorpha.* In the structure of the mouth parts it is similar to *Melecta* s. str., whereas the tarsal and antennal characters agree with *Melectomorpha.* In character of pubescence it is more or less intermediate between the two. The only unique characters possessed by *Xeromelecta* are the black wings and unarmed mesoscutellum.

Melecta (Xeromelecta) larreae (Cockerell)

larreae COCKERELL, 1900, Can. Ent., 32: 361, ♀ (*Bombomelecta*); VIERECK, 1903, Trans. Am. Ent. Soc., 29: 179, ♀ (*Bombomelecta*); LINSLEY, 1938, Ent. News, 49: 161, ♀ ♂ (*Bombomelecta*).

azygos VIERECK, 1903, Trans. Am. Ent. Soc., 29: 181, ♂ (*Bombomelecta*).

Female.—Black, clothed with black pubescence except supra-clypeal area, occiput, mesoscutum, and sides of abdominal tergites two and

three where the pubescence is mostly or entirely fulvous to fulvochraceous. *Head* elongate, facial line a little longer than transfacial line; face clothed with moderately long, erect, black hairs which are intermixed with fulvous on occiput and above and between antennal bases; antennae with first flagellar segment nearly as long as the two following together, segments two to eleven nearly as long as broad, scape sparsely clothed with erect, black hairs, diameter at apex not less than that of flagellum; clypeus prominent, moderately coarsely, closely punctured, sparsely clothed with erect, black hairs which are more numerous at base; labrum with a large, impunctate callous on each side at base. *Mesoscutum* densely clothed with short, erect, fulvous hairs, surface opaque, moderately coarsely, closely punctured; mesoscutellum sparsely clothed with erect, black hairs slightly longer than those of scutum, surface coarsely, closely punctured, dorsal lobes unarmed; mesepisterna coarsely, closely punctured moderately densely clothed with erect, black hairs which do not obscure the surface; wings nearly black; legs clothed with short, fine recumbent pubescence intermixed with scattered, longer, erect black hairs. *Propodeum* sparsely clothed with long, erect, black hairs. *Abdomen* finely, moderately closely punctured, clothed with suberect black hairs except apices of tergites two to five which have a broad, impunctate, finely tesselate, glabrous margin; first tergite without any erect pale hairs, tergites two and three usually with a transverse, lateral, fulvous fascia; pygidial field of sixth tergite broad at base, gradually narrowed to apex, surface convex and more or less medially, longitudinally, carinate. Length: 11–13 mm.

Male.—Face clothed entirely with black pubescence; flagellum of antennae stout, broader than scape, segments two to twelve transverse; abdominal fasciae, when present, small, not broad or conspicuous. Length: 10–13 mm.

Type locality: Mesilla Park, New Mexico.

Range locality: Desert region of southwestern United States. Definite localities include: NEW MEXICO: Dona Ana Co. (Mesilla Park); NEVADA; CALIFORNIA: Inyo Co. (Panamint and Argus Mts.), San Bernardino Co. (Deep Creek, Michel's Caverns), Riverside Co. (Riverside, Palm Springs), and San Diego Co. (Borego Valley).

Flight period: May.

Flower records: *Larrea*, *Eriodictyon*, *Stenotopsis*, and *Stanleya*.

Host: Unknown.

Melectomorpha Linsley, new subgenus

Melecta, PATTON, 1880, Bull. U. S. Geol. Surv., 5: 370; CRESSON, 1887, Trans. Am. Ent. Soc. (suppl), 128, 135; FOX, 1893, Ent. News, 4: 143; COCKERELL, 1898, Bull. Sci. Lab. Den. Univ., 11: 61; COCKERELL, 1898, Bull. Univ. New Mex., 1: 61; ASHMEAD, 1899, Trans. Am. Ent. Soc., 26: 66; COCKERELL AND ATKINS, 1902, Ann. Mag. Nat. Hist., (7) 10: 45; BAKER, 1906, Invert. Pac., 1: 143.

Pseudomelecta, COCKERELL, 1910, Ann. Mag. Nat. Hist., (8) 5: 27; COCKERELL, 1910, Univ. Colo., Studies, 7: 183, 192.

Maxillary palpi slender, four-segmented, the segments very unequal in length, the last minute, together shorter than basal segment of labial palpi; mandibles with inner margin bidentate (fig. 6); antennae of male with segments four to twelve very strongly transverse. Dorsum of thorax clothed with short, appressed, patch-like pubsecence; mesoscutellum biconvex, posterior margin only feebly projecting over metanotum, dorsal lobes armed with a posterior tooth; wings lightly infuscated or mottled with brownish, marginal cell truncate at apex; inner rami of claws of intermediate and posterior tarsi short, lobe-like, expanded vertically (fig. 8). Abdomen with first tergite fasciate, without a pubescence of dense, erect hairs; abdominal fasciae formed of prostrate, scale-like hairs.

Type: Melecta californica Cresson.

The members of this group have usually been considered generically distinct from *Melecta* (*Bombomelecta*). Cockerell (1910: 27) referred the species to *Pseudomelecta* Radoszkowski, a genus based on the Siberian *P. diacantha* Eversman. Through the kindness of Dr. Cockerell I have been able to examine a specimen of the Eversman species (subsequently presented by him to the California Academy of Sciences). This specimen confirms the revised opinion expressed by Dr. Cockerell when he sent it, that our species are not correctly referable to *Pseudomelecta*. The American species have a biconvex mesoscutellum with only a short posterior tooth, short, four-segmented maxillary palpi, and mandibles with the inner margin bidentate. From *Melecta* s. str., *Melectomorpha* may be distinguished by the structure of the mandibles and maxillary palpi, the expanded, lobe-like, inner tarsal claw and the appressed, patch-like pubescence.

KEY TO THE SPECIES OF MELECTOMORPHA

FEMALES

1. Pygidial area of sixth abdominal tergite broadly triangular, distinctly less than twice as long as basal width, surface dull, granulate punctate; scutellar tubercles short, obtuse; anterior wings fuscous except for a small spot at apex of discoidal and third submarginal cells.....2
   Pygidial area of sixth abdominal tergite elongate triangular, at least twice as long as basal width, surface shining; scutellar tubercles acute; anterior wings hyaline mottled with fuscous.....3
2. Pygydial area of sixth abdominal tergite broadly rounded or subtruncate at apex; vertex, behind median ocellus dull, closely punctured; posterior one-half of mesoscutum dull, the punctures very closely placed, nearly adjoining, 11–13 mm. Texas to Nebraska.....**interrupta**
   Pygydial area of sixth abdominal tergite narrowly rounded at apex; vertex, behind median ocellus, with an irregular, polished, impunctate area; posterior one-half of mesoscutum shining, the punctures slightly separated. 14 mm. New Mexico to Colorado.....**rociadensis**
3. Pygydial area narrowed slightly before apex, apex narrowly rounded; face above antennal bases clothed mostly with white hairs; tarsal pubescence

white and black intermixed; basal abdominal declivity distinctly fasciate. 8–14 mm. Summer and fall species. California to Nebraska, Texas, and northern Mexico.....**californica**

Pygidial area with sides straight, apex narrowly truncate; face above antennal bases clothed mostly with black hairs; tarsal pubescence entirely black; basal abdominal declivity non-fasciate. 13–14 mm. Spring species. California to British Columbia.....**pasadenensis**

MALES

1. Seventh tergite shallowly emarginate at apex; mesoscutellar tubercles acute; anterior wings hyaline mottled with fuscous.....2

Seventh tergite deeply emarginate at apex; mesoscutellar tubercles obtuse; anterior wings fuscous except for a small spot at apex of discoidal and third submarginal cells. 10–13 mm. Texas to Nebraska.....**interrupta**

2. Face above antennal bases clothed mostly with white hairs; tarsal pubescence white and black intermixed; basal abdominal declivity distinctly fasciate; apical one-half of mandibles black or piceous. 7–13 mm. Summer and fall species. California to Nebraska.....**californica**

Face above antennal bases clothed mostly with black hairs; tarsal pubescence all black; basal abdominal declivity non-fasciate; apical one-half of mandibles pale, rufotestaceous. 13–14 mm. Spring species. California to British Columbia.....**pasadenensis**

Melecta (Melectomorpha) interrupta Cresson

interrupta Cresson, 1872, Trans. Am. Ent. Soc., 4: 275, ♀ ♂; Fox, 1893, Ent. News, 4: 143, ♀ ♂; Cockerell, 1898, Bull. Sci. Lab. Den. Univ., 11: 61; Cockerell, 1898, Bull. Univ. N. Mex., 1: 61; Cockerell, 1904, Ann. Mag. Nat. Hist., (7) 12: 23; Cockerell, 1907, Univ. Colo. Studies 5: 37, ♂; Cockerell, 1910, Ann. Mag. Nat. Hist., (8) 5: 27 (*Pseudomelecta*).

fallugiae Cockerell, 1904, Ann. Mag. Nat. Hist. (7) 14: 23, ♀ (*interrupta* var.).

Female.—Black, middle of face, occiput in part, anterior margin of scutum, upper margin of mesepisterna, sides of propodeum, and abdominal bands clothed with pale ochraceous, tawny, or reddish fulvous pubescence. *Head* with vertex, behind median ocellus, dull, very closely punctured; occiput with a band of black hairs on each side of middle; clypeus subglabrous, finely, closely punctured. Mesoscutum with a band of black pubescence on each side of middle of anterior margin, disc subglabrous, posterior one-half dullish, closely punctured; tegulae black with a faintly reddish margin; mesoscutellum subglabrous and punctured similarly to mesoscutum, dorsal tubercles short, obtuse; wings fuscous except for a small hyaline spot at apex of discoidal and third submarginal cells; legs piceous to black, frequently with whitish pubescence at apex of femora, base of tibiae, and on tarsal segments. *Abdomen* tessellate, dullish, tergites one to five with a broad band of appressed pubescence along apical and lateral margins, narrowly separated at middle of first tergite, successively more widely separated on following segments; basal declivity of first tergite non-fasciate; pygidial area of sixth tergite broadly triangular, less than twice as long as basal width, sides slightly incurved, apex obtusely rounded or subtruncate, surface dull, granulate. Length: 11–13 mm.

Male.—Clypeus with a tuft of ochraceous or tawny pubescence at base; tegulae frequently reddish; outer face of intermediate tibiae with a dense patch of short, velvety, whitish pubescence; seventh abdominal tergite shallowly emarginate at apex. Length: 10–13 mm.

Lectotype: No. 2291, Acad. Nat. Sci. Phila. (Cresson designation, 1916), ♀.

Range: Great Plains region east of the Rocky Mountains, primarily in the Upper Sonoran Zone. Definite localities include: TEXAS: Dallas Co., Comal Co., Kerr Co. (Kerrville), Lee Co. (Fedor); NEW MEXICO: San Miguel Co. (Pecos), Cimmaron; KANSAS: Sherman Co., Ness Co., Cheyenne Co.; NEBRASKA: Sioux Co. (Glen, Warbonnet Cn.), Brown Co. (Long Pine), Cumming Co. (West Point).

Flight period: June to August.

Flower records: *Cleome, Petalostemon, Monarda.*

Host: Unknown.

This species may be easily recognized by the broadly rounded or subtruncate apex of the pygidium of the female. The pale pubescence varies from ochraceous to fulvous and the black bands on the anterior half of the scutum may be broad or narrow. *M. interrupta fallugiae* Cockerell (type No. 4672, Calif. Acad. Sci. Ent.) is a color variety with the pubescent markings reddish fulvous. The type locality for this form is Pecos, New Mexico, and I have seen similar specimens from Cimmaron, New Mexico (E. G. Anderson) and Kansas (F. X. Williams).

Melecta (Melectomorpha) rociadensis (Cockerell)

rociadensis COCKERELL, 1904, Ann. Mag. Nat. Hist., (7) 14: 23 (*interrupta* var.).

Female.—Black, middle of face, occiput in part, anterior margin of scutum, upper mesepisterna, metanotum and propodeum at sides, and abdominal fasciae clothed with ochraceous pubescence. *Head* with irregular, polished, impunctate (or very sparsely punctate) glabrous area behind median ocellus, occiput with a patch of blackish hairs on each side of middle; clypeus subglabrous, finely, closely punctured. *Mesonotum* with an unbroken band of pale pubescence along anterior margin, disc subglabrous, posterior one-half shining, the punctures close but distinctly separated; tegulae rufo-piceous; mesoscutellum subglabrous, surface punctured similarly to mesoscutum, dorsal tubercles short, obtuse; wings fuscous except for a small hyaline spot at apex of discoidal and third submarginal cells; legs piceous, clothed with brownish black hairs. *Abdomen* tessellate, dullish, tergites one to five with a broad band of appressed ochraceous pubescence along apical and lateral margins, narrowly interrupted at middle of first tergite, successively more widely separated on the following segments; basal declivity of first tergite non-fasciate; pygidial area of sixth tergite broadly triangular, less than twice as long as basal width, apex narrowly rounded, surface dull, granulate. Length: 14 mm.

Type locality: Rociada, New Mexico.

Range: New Mexico to Colorado. Definite records: NEW MEXICO: San Miguel Co. (Rociada); COLORADO: Huerfano Co. (Gardner), Yuma Co. (Wray), Boulder Co. (Peaceful Valley), Jefferson Co. (Leyden), El Paso Co. (Manito Park).

Flight period: July–August.

Flower records: None.

Host: Unknown.

The above description is based on a specimen from near Leyden, Colorado, very kindly sent by Dr. T. D. A. Cockerell. I have also seen a specimen from Manitou Park, Colorado, in the F. H. Snow collection at the University of Kansas. The species is close to *interrupta* Cresson but may be distinguished, in the female, by the shape of the pygidial area and the punctation of the vertex and scutum. I have not seen the male.

Melecta (Melectomorpha) californica Cresson

californica CRESSON, 1878, Trans. Am. Ent. Soc., 7: 91, ♂ ♀.

Female.—Black, head and thorax densely clothed with cinerous and black pubescence. *Head* with occiput clothed with whitish hairs, interrupted on each side of middle by a patch of dark pubescence, vertex sparsely pubescent, face above and below antennal bases clothed mostly with long, white hairs; clypeus shining finely, closely punctured, apex sparsely pubescent. *Mesonotum* with a patch of black pubescence on each side of middle along anterior margin, disc subglabrous, shining, coarsely punctured, the punctures varying from less than one to nearly one puncture width apart on posterior one-half; tegulae rufo-piceous; mesepisterna clothed almost entirely with white pubescence; mesoscutellum more coarsely, irregularly punctured, glabrous except along margins, dorsal lobes acute; wings hyaline mottled with fuscous, the apices broadly fuscous; legs black or rufo-piceous, femora fringed behind with long, loose white hairs, tibiae annulated with white pubescence, tarsi clothed with white and black pubescence intermixed. *Abdomen* dullish, tessellate, tergites one to five with a broad band of appressed whitish pubescence along apical and lateral margins, narrowly separated on first tergite, successively more widely separated on following segments; basal declivity with a pubescent fascia on each side of middle; pygidial area of sixth tergite elongate triangular, more than twice as long as basal width, apex very narrowly rounded, surface polished, shining.

Male.—Clypeus densely clothed with white pubescence; outer face of intermediate tibiae with a dense patch of short, white, velvety pubescence; tegulae frequently testaceous; apex of seventh abdominal tergite deeply notched.

This species may be readily distinguished from *interrupta* and *rociadensis* by the mottled wings, longer and more acute scutellar lobes, and very narrow pygidial area of the female. Two subspecies are recognizable, distinguished mainly in size.

Melecta californica californica Cresson

californica CRESSON, 1878, Trans. Am. Ent. Soc., 7: 91, ♂ ♀; FOX, 1893, Ent. News, 4: 143, ♀ ♂; FOWLER, 1902, Rept. Univ. Calif. Exp. Sta., 1898–1901: 327; COCKERELL, 1910, Ann. Mag. Nat. Hist., (8) 5: 27 (*Pseudomelecta*).

Length: 7.5–10 mm.

Lectotype: No. 2292, Acad. Nat. Sci. Phila. (Cresson designation, 1916) ♂.

Type locality: California.

Range: Pacific coast from Arizona to Oregon, primarily in the Sonoran and Transition Life Zones. Records include: ARIZONA: Cochise Co., Pinal Co. (Oracle); NEVADA: Carson City; CALIFORNIA: Nearly every county from Trinity, Shasta, and Modoc to San Diego; OREGON: Lake Co. (Warner Mts.), Klammath Co. (Crater Lake, Klammath Lake), Baker Co. (Sparta), Jackson Co. (Colestin), Fremont National Forest, Wamples Landing.

Flight period: March to December.

Flower records: Various, but especially Compositae (see below).

Host: *Anthophora urbana* Cresson, *Anthophora* spp.

This subspecies is common throughout the range of its usual host, *Anthophora urbana* Cresson. It is most bundant during the summer and fall, although in southern California it has been taken by Timberlake as early as March 4 and as late as December 4. The wide variety of flowers visited is indicated by the following records from ninety-six examples captured at a single locality, Riverside, California, by Mr. P. H. Timberlake (the number in parenthesis indicates the number of specimens involved): *Eriogonum fasciculatum* (7), *E. gracile* (1), *Brassica incana* (1), *Eremocarpus setigerus* (2), *Phacelia distans* (1), *Cryptantha* (3), *Trichostema lanceolatum* (5), *Marrubium* sp. (5), *Guiterrezia californica* (17), *Ericameria palmeri* (22), *Pluchea camphorata* (4), *Encelia farinosa* (5), *Coreopsis lanceolata* (3), *Hemizonia paniculata* (11), *Senecio douglasii* (14), *Duranta plumieri* (1), *Lepidospartum squamatum* (2). Of these ninety-six records, seventy are from Compositae, of which the four genera *Guiterrezia*, *Hemizonia*, *Senecio*, and *Ericameria* account for more than one-half of the captures (54).

Davidson (1897, Proc. So. Calif. Acad. Sci., 1 : 5) was the first to record the host of this species. His host was identified by Ashmead as *Anthophora montana* Cresson, but this was apparently a misdetermination for what must have been *urbana*

Cresson. *M. californica* has been observed as a parasite of the latter species at Altadena, Calif. (Michener), Westwood Hills, Los Angeles, Calif. (Linsley), and in numerous other localities. The writer has also captured *californica* in large numbers flying about the nests of an apparently undescribed species of *Anthophora* at Deep Creek, Mojave Desert, Calif.

Melecta californica miranda (Fox)

miranda Fox, 1893, Ent. News, 4: 143; Cockerell, 1898, Bull. Sci. Den. Univ., 11: 61; Cockerell, 1898, Bull. Univ. New Mex., 1: 61; Cockerell, 1910, Ann. Mag. Nat. Hist., (8) 5: 27 (*Pseudomelecta*).

Length: 9–14 mm.

Type: No. 10129, Acad. Nat. Sci. Phila., ♀.

Type locality: Rapid City, South Dakota.

Range: Great Plains, east of Rocky Mountains, primarily in the Transition life zone. Definite localities: South Dakota: Rapid City; Nebraska: Sioux Co. (Glen), Scott's Bluff Co. (Gering), Cass Co. (Weeping Water), Lancaster Co. (Lincoln); Kansas: Ness Co.; Colorado: Larimer Co., Otero Co. (La Junta), Ute Pass; New Mexico: Dona Ana Co. (Mesilla Valley), Santa Fe, Tularosa Creek, Las Vegas; Texas: Val Verde Co. (Devil's River); Mexico: locality unrecorded.

Flight period: May to September.

Flower records: *Monarda, Cleome, Sphaeralcea, Zinnia, Asclepias*, etc.

Hosts: *Anthophora neomexicana* (Ckll.) and *A. occidentalis* Cresson.

This subspecies occurs in a different region from that of *californica* s. str., has different hosts, and the average size is one to two millimeters longer. Its habits have been discussed by Hicks (1926, Univ. Colo. Studies, p. 224) and Mickel (1928, Ent. News, 39: 73). It was first recorded as a parasite of *A. occidentalis* by Cockerell (1899, Entom., 32: 156, f. n.).

Melecta (Melectomorpha) pasadenensis (Cockerell)

pasadenensis Cockerell, 1910, Ann. Mag. Nat. Hist. (8) 5: 27, ♀ (*Pseudomelecta*); Cockerell and Sandhouse, 1924, Proc. Calif. Acad. Sci. (4) 13: 323 (*Pseudomelecta*).
sladeni Viereck, 1924, Can. Ent., 56: 15.

Female.—Black, head and thorax clothed with cinerous and black pubescence. *Head* with occiput clothed with whitish hairs, interrupted on each side of middle by a patch of dark pubescence, vertex sparsely pubescent, sides of face above and below antennal bases clothed mostly with black hairs; antennae with first flageller segment one and one-fifth times as long as second; clypeus shining, finely closely punctured, apex

subglabrous. *Mesoscutum* with a large patch of black pubescence on each side of middle on anterior margin, disc subglabrous, shining, coarsely, closely punctured; tegulae dark piceous, the margins reddish, mesepisterna clothed almost entirely with black pubescence; *mesoscutellum* subglabrous, coarsely, irregularly punctured, dorsal lobes subacute; wings hyaline mottled with fuscous, apices broadly fuscous; legs black, femora fringed behind with long, white, flying hairs, tibiae annulated with white pubescence, tarsal pubescence all black. *Abdomen* dullish, tessellate, tergites one to five with a broad band of appressed, whitish pubescence along apical and lateral margins, narrowly interrupted at middle; basal declivity of first tergite non-fasxiate; pygidial area of sixth tergite elongate triangular, more than twice as long as basal width, sides straight, apex narrowly truncate, surface polished, shining. Length: 13–14 mm.

Male.—Clypeus densely clothed with whitish pubescence; outer face of middle tibiae with a dense patch of short, white, velvety pubescence; tegulae rufo-piceous; apex of seventh tergite deeply notched. Length: 13–14 mm.

Type locality: Pasadena, Calif.

Range: Pacific coast of North America. Localities: CALIFORNIA: Los Angeles Co. (Pasadena), San Francisco Co. (San Francisco); BRITISH COLUMBIA: Summerland.

Flight period: April.

Flower records: None.

Host: Unknown.

M. pasadenensis is very closely related to *M. californica* and occurs in part of the territory of the typical race of the latter species. From the material at hand it would appear, however, that *pasadenensis* occurs primarily along the coast, flies in the spring, and extends further north than *californica* s. str. It is also larger, with the facial pubescence darker and the tarsi all black and differs in the shape of the female pygidial area. The first segment of the flagellum, particularly in the male, is perceptibly longer in *pasadenensis*, but the difference is such that it does not lend itself to accurate description.

Melecta sladeni Viereck (type: No. 652, Can. Nat. Coll.) agrees with specimens of *pasadenensis* from San Francisco (Blaisdell collection, Calif. Acad. Sci.).

Brachymelecta Linsley, new genus

Male.—Small, moderately robust, densely clothed with short, appressed pubescence. *Head* narrower than thorax; antennae short, pedicel reduced to a narrow transverse, densely pubescent ring, flagellum slender, nude, first segment cylindrical, scarcely longer than second

segment, remaining segments but little broader than long; median ocellus a little larger than lateral ocelli, ocelli separated by the diameter of median ocellus; apical margin of clypeus bisinuate; mandibles with a stout tooth on inner margin. Thorax robust; *mesoscutellum* bilobed, apices of lobes acute; anterior wings with two submarginal cells, the second a little longer than the first, receiving both recurrent nervures, the first at basal one-fifth, the second a little beyond the middle; marginal cell short, not longer than second submarginal cell, apex broadly rounded, transverse cubital veins received by marginal cell about equidistant from base and apex. Abdomen short, convex; seventh abdominal tergite with a well-defined pygidial field.

Genotype: *Melecta mucida* Cresson.

This genus resembles *Zacosmia* Ashmead, but differs in the longer wings, which extend well beyond the apex of the body and which have only two submarginal cells, the acutely lobed scutellum, the filiform antennae of the male, the dense, unbroken abdominal pubescence, and the absence of a pygidium in the male. The following is the only known species.

Brachymelecta mucida (Cresson)

mucida Cresson, 1879, Trans. Am. Ent. Soc. 7: 205, ♂ (*Melecta?*); Fox, 1893, Ent. News. 4: 143. ♂ (*Melecta*).

Male.—Black; densely pubescent. *Head* densely clothed with long, cinereous hairs, varied with brownish at sides of face and occiput; clypeus moderately, coarsely, closely punctured. *Thorax* densely clothed with long cinereous hairs except on disk of scutum and scutellum; scutellum with a tuft of short black hair on each side near margin; tegulae testaceous; legs moderately clothed with subrecumbent hairs; anterior femora with a dense fringe of long, flying hairs externally, the hairs longer than the width of the femora; wings hyaline, apex smoky. Abdomen densely clothed with short, depressed, cinereous pubescence. Length: 9 mm.; anterior wing, 8 mm.

Type: No. 2294, Acad. Nat. Sci. Phil., ♂.

Type locality: Nevada.

Apparently this species is known only by the type. Its uniformly pubescent abdomen gives it a unique appearance in the Melectinae.

Genus **Zacosmia** Ashmead

Zacosmia Ashmead, 1898, Psyche, 8: 282; Ashmead, 1899, Trans. Am. Ent. Soc., 26: 65.

Micromelecta Baker, 1906, Invert. Pacifica, 1: 143.

Small, robust, clothed with short, depressed pubescence, arranged in patches. *Head* narrower than thorax; antennae short, not attaining tegulae, scape stout in the male, slender in the female, pedicel short,

ring-like in the male, about three-fourths as long as broad in the female, flagellum of female filiform, segments beyond the first scarcely wider than long, flagellum of male fusiform, intermediate segments very strongly transverse; labrum broad, short; mandibles with a stout tooth on inner margin; maxillary palpi with one free segment; labial palpi with last two segments cylindrical, the ultimate segment very small. *Thorax* robust; mesoscutellum convex, more strongly bilobed in the male, the lobes in both sexes broadly rounded, unarmed; intermediate and posterior legs moderately stout, clothed with depressed pubescence, intermediate tibiae of males without a dense external pad of white, felt-like pubescence, intermediate and posterior tibial spurs simple in both sexes; anterior wings short, barely surpassing apex of body, marginal cell very short, not attaining apical margin of third submarginal cell, cubital margin of first discoidal cell nearly straight, discoidal vein intersecting basal vein (fig. 4). *Abdomen* short, broadly oval, convex; sixth tergite of female with a large, broad, slightly convex or carinate triangular pygidial field, covering most of dorsal surface of segment; seventh tergite of male with a narrow, concave, pygidial field, the lateral margins well elevated.

Genotype: Melecta maculata Cresson (original designation).

This genus differs from all other known melectine bees in the presence of a pygidial field in the male. The maxillary palpi are one-segmented and the flagellum of the male greatly enlarged, with the intermediate segments strongly transverse. The marginal cell of the anterior wing is very short and the discoidal vein intersects the basal vein. The following key will separate the two known species:

FEMALES

1. Antennae with first segment of flagellum as long as or longer than the two following together; mesoscutellum distinctly bilobed. 6.5–7 mm. Great Basin, southwestern U. S. and northern Mexico..... **maculata**
   Antennae with first segment of flagellum shorter than the two following together; mesoscutellum feebly bilobed. 7 mm. Alberta..... **suffusa**

Zacosmia maculata (Cresson)

(Pl. I, fig. 4)

maculata Cresson, 1878, Trans. Am. Ent. Soc., 7: 204, ♀ ♂ (*Melecta*).

Female.—Black, clothed with short cinereous and black pubescence. *Head*, except clypeus and vertex clothed with cinereous pubescence, that of vertex varied with brownish and black; antennae with first flagellar segment as long as or longer than the two following together; clypeus subglabrous, polished, shining, coarsely but very sparsely punctured. *Mesoscutum* nearly glabrous, disc closely punctured, with a polished, sparsely punctured area on each side near tegulae; tegulae reddish; mesepisterna with upper two-thirds densely clothed with white pubescence, lower mesepisterna very coarsely, contiguously and subcontiguously punctured; scutellum distinctly bilobed, moderately coarsely, closely punctured; wings with a dark streak across second and

third submarginal cells, apical margin dusky mottled with hyaline; legs sparsely clothed with long, pale hairs, tibiae annulated with whitish pubescence. *Abdomen* opaque, tergites one to four with a broad, irregular, sinuate band of white depressed pubescence along apical margins; pygidial area of sixth tergite dullish.

Male.—Clypeus sparsely clothed with brownish hairs; pygidial field of seventh tergite concave, shining.

Two phases of this species exist and with the limited material available for study I am unable to determine with any degree of certainty whether they represent varieties or subspecies. In California one form (*desertorum*) appears to be confined to desert and semi-arid regions, the other (*maculata* s. str.) to coastal and mountainous areas. The two may be separated as follows:

FEMALES

1. Antennae, legs, pronotal tubercles, and sternites piceous or black; darker areas of abdomen clothed with brownish black pubescence. 6.5–7 mm. New Mexico to California.....**maculata** s. str.
   Antennae, legs, pronotal tubercles, and sternites pale reddish; darker areas of abdomen clothed with pale yellowish prown pubescence. 6.5–7 mm. Texas and Chihuahua to California.....**maculata desertorum**

MALES

1. Antennal scape, legs, tegulae, and pygidial field piceous or black; darker areas of abdomen clothed with brownish black pubescence; abdominal sternites sparsely pubescent. 7 mm. New Mexico to California. **maculata** s. str.
   Antennal scape, legs, tegulae, and pygidial field reddish; darker areas of abdomen clothed with pale brownish pubescence; abdominal sternites densely clothed with white pubescence. 6.5–7 mm. Texas and Chihuahua to California.....**maculata desertorum**

Zacosmia maculata maculata (Cresson)

maculata CRESSON, 1878, Trans. Am. Ent. Soc., 7: 204, ♀ ♂ (*Melecta*); FOX, 1893, Ent. News, 4: 143, ♀ ♂ (*Melecta*); COCKERELL, 1898, Bull. Sci. Lab. Den. Univ., 11: 61 (*Melecta*); COCKERELL, 1898, Bull. Univ. New Mex., 1: 61 (*Melecta*); ASHMEAD, 1898, Psyche, 8: 283; BAKER, 1906, Invert. Pac., 1: 143 (*Micromelecta*).

Female.—Antennae, legs, pronotal tubercles, and abdominal sternites piceous or black; darker areas of abdomen clothed with brownish black pubescence. Length: 6.5–7 mm.

Male.—Antennal scape, tegulae, legs, and pygidial field piceous or black; abdominal sternites sparsely pubescent. Length: 7 mm.

Lectotype: No. 2293, Acad. Nat. Sci. Phila. (Cresson designation, 1916), ♂.

Type locality: Nevada.

Range: Great Basin area and southwestern United States and northern Mexico, in the Upper and Lower Sonoran Zones. Definite localities include: WASHINGTON: Whitman Co. (Walla Walla); CALIFORNIA: Contra Costa Co. (Antioch), Stanislaus Co., San Bernardino Co. (Colton), Riverside Co. (Idyllwild),

Los Angeles Co. (Claremont, Altadena, Eagle Rock, Corona, San Pedro), San Diego Co. (San Diego); NEW MEXICO: Dona Ana Co. (Mesilla Valley).

Flight period: May to August.

Flower records: None.

Host: ? *Micranthophora* spp.

Zacosmia maculata desertorum Cockerell

maculata desertorum COCKERELL, 1916, Can. Ent., 48: 391, ♂.

Female.—Antennae, legs, pronotal tubercles, and abdominal sternites pale reddish; darker areas of abdomen clothed with pale yellowish brown pubescence. Length: 6.5–7 mm.

Male.—Antennal scape, tegulae, legs, and pygidial field reddish; abdominal sternites densely clothed with white pubescence. Length: 6.5–7 mm.

Type locality: Chihuahua, Mexico.

Range: Desert and semi-desert regions of southwestern United States and northern Mexico. Definite localities: TEXAS: Brewster Co.; MEXICO: Chihuahua; ARIZONA; CALIFORNIA: Fresno Co. (Selma), Riverside Co. (Palm Springs, Cathedral City), Imperial Co. (Westmoreland); LOWER CALIFORNIA.

Flight period: May.

Flower records: None.

Host: Unknown.

Zacosmia suffusa (Viereck)

suffusa VIERECK, 1924, Can. Ent., 56: 15, ♀ (*Pseudomelecta?*).

Female.—Black, clothed with short cinereous and black pubescence. *Head*, except clypeus and vertex clothed with whitish pubescence; antennae black, first segment of flagellum shorter than the two following together; clypeus polished, coarsely, sparsely punctured. *Mesoscutum* subglabrous, shining, coarsely, closely punctured; mesoscutellum very feebly bilobed, coarsely, closely punctured; wings with a dark streak across second and third submarginal cells, apical margin dusky, mottled with hyaline; legs black, sparsely clothed with long pale hairs, tibia more or less annulated with whitish pubescence. *Abdomen* opaque, tergites one to four with a board, irregular, sinuate band of white pubescence along apical margins, darker areas suffused with whitish pubescence; pygidial field shining, sparsely punctate, with a median longitudinal carina. Length: 7 mm.

Type: No. 653, Canadian National Collection, ♀.

Type locality: Medicine Hat, ALBERTA.

Zacosmia suffusa resembles, and may eventually prove to be the same as, *Z. maculata desertorum* Ckll. At present only the

female is known and this appears to differ slightly in the proportions of the first three antennal segments and the structure of the mesoscutellum. Although Viereck records a paratype male, the specimen proved upon examination (1937) to be a female.

Genus Ericrocis Cresson

Ericrocis Cresson, 1887, Trans. Am. Ent. Soc. (suppl.), pp. 131, 134; Cockerell, 1898, Bull. Lab. Den. Univ., 11: 61; Cockerell, 1898, Bull. Univ. New Mex., 1: 61; Ashmead, 1899, Trans. Am. Ent. Soc., 26: 66; Cockerell and Atkins, 1902, Mag. Nat. Hist., (7) 10: 46; Baker, 1906, Invert. Pacifica, 1: 143; Cockerell, 1923, Proc. Calif. Acad. Sci., (4) 12: 93.

Robust; clothed with depressed white or tawny pubescence; abdomen fasciate, the fasciae composed of dense, recumbent, scale-like hairs. *Head* very much narrower than thorax; ocelli nearly in a straight line; antennae short, but attaining tegulae, scape slender, apex scarcely wider than median flagellar segments; pedicel a little broader than long; flagellum slender, first segment not longer than second; labrum broader than long, surface densely hairy; mandibles with a stout tooth on inner margin; maxillary palpi short, two-segmented, the basal segment stout, cylindrical, the second segment slender, shorter than first; labial palpi with the last two segments short, broad, flattened. *Thorax* large and robust; mesoscutellum very convex, median longitudinal furrow shallow, dorsal lobes broadly rounded, unarmed; intermediate and posterior legs moderately stout, clothed with depressed hairs, tarsal claws cleft, intermediate tibial spurs bifurcate or multispinose at apex, of female simple; anterior wings elongate, far surpassing apex of abdomen, marginal cell long, attenuated apically, extending well beyond third submarginal cell, cubital vein straight, discoidal vein separated basally from basal vein (fig. 5). *Abdomen* short, broadly oval, convex; sixth tergite of female triangular, disk without a definite pygidial field; seventh tergite of male bilobed, disk without a pygidial field.

Genotype: Crocisa? lata Cresson (by single reference).

This genus stands alone among other North American melectine bees by reason of the long marginal cell of the anterior wing, absence of a pygidial field in the female, and bifurcate intermediate tibial spurs of the male. It may possibly be related to the South American *Acanthopus*, which has rather similar wing venation and bifurcate intermediate tibial spurs. In this latter genus, however, the tibial spurs are broad and flat, serrated apically. Insofar as known at present, *Ericrocis* is confined to the arid regions of southwestern United States and northern Mexico, but the writer has seen bees from Chile which may belong to this or a closely related genus. The known species may be separated as follows:

KEY TO THE SPECIES OF ERICROCIS

FEMALES

1. Wings tinted with fuscous; pubescence of face and pleura tawny; anterior margin of mesoscutellum white pubescent; punctures of mesoscutum finer, those of disk mostly separated by about one puncture width; mesepisterna moderately coarsely, irregularly punctured; sixth abdominal tergite coarsely punctured at base. 11–12 mm. Arizona, California, Lower California (north), and Sonora.....**arizonensis**

Wings very dark blackish throughout; pubescence of face and pleura mostly silvery white; anterior margin of mesoscutellum black pubescent; punctures of mesoscutum coarser, those of disk very close, scarcely separated; lower mesepisterna coarsely punctured, with a large irregular, polished, impunctate area at middle; sixth abdominal tergite finely punctured at base. 10 mm. Lower California (Cape Region).....**rossi**

MALES

1. Third submarginal cell but little longer than second; anterior margin of mesoscutellum white pubescent.....2

Third submarginal cell twice as long as second; anterior margin of mesoscutellum black pubescent. 10 mm. Texas and New Mexico.....**lata**

2. Anterior wings hyaline, marginal cell and apical margin tinted with fuscous; punctures of mesoscutum finer, those of disk separated by about one puncture width.....3

Anterior wings fuscous throughout, anterior and apical margins darker; punctures of mesoscutum coarser, those of disk very close, separated by very much less than one puncture width. 11 mm. Lower California (Cape Region).....**rossi**

3. Legs reddish brown; abdominal fasciae tawny, bands of first tergite separated by more than their length from anterior to posterior. 12 mm. Lower California (Cape Region).....**rugosa**

Legs black; abdominal fasciae white, bands of first tergite separated by less than their length from anterior to posterior. 10–12 mm. Arizona, California, Lower California (north), and Sonora.....**arizonensis**

Ericrocis lata (Cresson)

lata CRESSON, 1878, Trans. Am. Ent. Soc., 7: 91, ♂ (*Crocisa?*); CRESSON, 1887, Trans. Am. Ent. Soc. (suppl. vol.) p. 298; COCKERELL, 1898, Bull. Sci. Lab. Denis. Univ., 11: 61; ♂ ♀; COCKERELL, 1898, Bull. Univ. New Mex., 1: 61, ♂ ♀; BAKER, 1906, Invert. Pac., 1: 143.

Male.—"Form short, broad, very robust, black, finely punctured; head shining, sides of the face, clypeus, cheeks and occiput clothed with rather long white pubescence; antennae obscure testaceous at tip and beneath; mesothorax nude between the wings, subopaque, finely carinate on lateral margin with a longitudinal impressed line on the disk and another less deep on each side; thorax in front, at sides and behind clothed with long whitish pubescence; a patch on each side of mesothorax anteriorly, a tuft on each side behind tegulae, a patch behind scutellum and the anterior margin of pleura clothed with black pubescence; scutellum sub-bilobate, broadly depressed on disk; tegulae pale testaceous; wings tinged with yellowish fuscous, a dark streak at tip of marginal cell, which is elongate, lanceolate, the tip rounded and extending beyond the third submarginal cell, second submarginal cell narrow, obliquely subquadrate, the first recurrent nervure uniting with the second transverse cubital nervure, third submarginal about twice

the breadth of the second, the apical nervure obtusely angular, receiving the second recurrent nervure at about the middle; legs clothed with black pubescence, a patch on coxae and on base and apex of tibiae above of white pubescence, the femora beneath shining and fringed with black pubescence, the posterior legs robust; abdomen short, broad, convex, opaque, a broad transverse spot on each side of first segment, and a large subangular mark, broadly dilated laterally, on each side of segments 2—5, of dense appressed white pubescence. Length: .40 inch."—Original description.

Type: No. 2486, Acad. Nat. Sci. Phila., ♂.

Type locality: Texas.

Range: Texas and New Mexico. Recorded localities: TEXAS; NEW MEXICO; Dona Ana Co. (Mesilla Park).

Flight period: April.

Flower records: *Caesalpinia.*[5]

Host: Unknown.

I have not seen the female of this species. Cockerell (1898: 61) states that the two sexes differ in wing venation, the third submarginal cell of the male being about twice as broad as the second, in the female hardly broader than the second.

Ericrocis rugosa Fox

rugosa FOX, 1893, Proc. Calif. Acad. Sci., (2) 4: 19, ♂; COCKERELL, 1923, Proc. Calif. Acad. Sci., (4) 12: 93, ♂.

Male.—Black; antennae, mandibles, and legs reddish brown; pubescence grayish white tawny, and black. *Head,* except vertex, densely pubescent; facial pubescence tawny and white; vertex finely, closely punctured at sides, a little more coarsely and sparsely at middle; antennae reddish, paler beneath. *Thorax* densely pubescent at sides; pronotal tubercles red; mesoscutum opaque, subglabrous, anterior margin clothed with brownish hairs; tegulae testaceous; mesepisterna densely clothed on upper half with white pubescence, lower half shining, moderately coarsely, closely punctured; mesosternum sparsely clothed with white pubescence; mesoscutellum subglabrous except for a thin line of white pubescence along sides and median line; wings subhyaline, marginal cell and apical margin tinted with fuscous; legs reddish brown, intermediate and posterior femora densely clothed beneath with heavily plumose, black hairs, outer face of tibiae with some white pubescence at base and apex. *Abdomen* black, dull, with a broad band of tawny pubescence on first tergite, the bands separated at middle by more than their length from anterior to posterior, and a subangular patch along apex and lateral margins on each side of tergites two to five; seventh tergite deeply notched at apex. Length: 12 mm.

Type: No. 277, Calif. Acad. Sci., Ent., ♂.

[5]Cockerell (i. litt.) informs me that this plant is now referred to *Hoffmannseggia.*

Type locality: Santa Maria, LOWER CALIFORNIA.

Flight period: May.

Host: Unknown.

The type and only known specimen of this species was collected in alcohol and the color of the integument and pubescence may have been altered. Likewise the notum, sternum, and legs appear rubbed, and the white pubescence may have originally been more extensive than described above. The species is undoubtedly close to the following.

Ericrocis arizonensis Baker

(Pl. I, fig. 3, 5)

arizonensis BAKER, 1906, Invert. Pac., 1: 143, ♂.
melectoides BAKER, 1906, Invert. Pac., 1: 144, ♀ (nec ♂).

Female.—Black, pubescence silvery white, brownish, and black. *Head*, except vertex, densely pubescent; pubescence of face yellowish white or tawny; vertex finely, closely punctured, area about ocelli polished, shining, more sparsely punctate; antennae piceous, reddish beneath. *Thorax* densely pubescent; pronotal tubercles black; mesoscutum very finely punctured, discal punctures separated by about one puncture width, anterior margin clothed with tawny pubescence except for a patch of black hair on each side of middle; tegulae testaceous, disk piceous; mesepisterna densely clothed on upper half with tawny pubescence, lower mesepisterna shining, subglabrous, moderately coarsely, irregularly punctured; mesosternum clothed with white pubescence; mesoscutellum clothed with short, fine, black pubescence except for anterior and lateral margins and median line which are clothed with white and tawny hairs; wings tinted with fuscous, apical margin darker; intermediate and posterior coxae and trochanters clothed beneath with white hairs; legs black, tarsi dark reddish, outer face of intermediate and posterior tibiae with a large patch of tawny white pubescence at base and apex. *Abdomen* black, dull, with a broad, transverse band of white pubescence on each side of first tergite, the bands separated by less than their length (anterior to posterior) and a subangular patch along apex and lateral margins on each side of tergites two to five; sixth tergite coarsely punctured at base; sternites dull, tessellate, clothed with short, fine, black pubescence. Length: 11–12 mm.

Male.—Pubescence of face and pleura silvery white; wings subhyaline, marginal cell and apical margin tinted with fuscous; intermediate and posterior femora densely fringed beneath with black, heavily plumose hairs intermixed with scattered, longer, white hairs; seventh abdominal tergite deeply notched at apex.

Type locality: Oracle, Arizona. Length: 10–12 mm.

Range: Deserts of southwestern United States and northern Mexico. Definite localities include: ARIZONA: Pinal Co. (Oracle, Walnut), Pima Co. (Tucson); CALIFORNIA: Riverside Co.

(Palm Springs, Twenty-nine Palms), San Bernardino Co. (Michel's Caverns). Imperial Co. (Coachella, Westmoreland), San Diego Co. (Warner Ranch); MEXICO: Sonora (Guayamas, San Bernardo); LOWER CALIFORNIA: El Marmol.

Flight period: March to September.

Flower records: *Cercidium, Chilopsis, Wislizenia.*

Host: ? *Centris* spp.

E. arizonensis is very close to *rugosa* Fox, a species which Baker overlooked completely. The type specimen of the latter is, however, in poor condition and it cannot be said with certainty that it is identical with Baker's species. Apparently, the two differ in the color of the legs and the arrangement and color of the abdominal pubescence. It therefore seems wise to maintain them as distinct until topotypical Lower California material can be obtained and their status clarified. The peninsular record above is based on a specimen collected by E. S. Ross and A. E. Michelbacher. The flower records are from P. H. Timberlake and C. D. Michener.

Baker described the two sexes of *arizonensis* as distinct species and the characters used to separate them were all sex characters. His *melectoides* is based on the female (not male), and the two sexes have been taken together at most of the localities given above.

Ericrocis rossi Linsley, new species

Female.—Black, pubescence white, brownish, and black. *Head,* except vertex, densely pubescent; pubescence of face white, of occiput and basal two-thirds of clypeus fulvochraceous, of apical margin of clypeus black; vertex finely, closely punctured at sides, polished, shining, sparsely and more coarsely in front of ocelli; antennae black, pedicel and first two flagellar segments slightly reddish. *Thorax* densely pubescent; pronotal tubercles reddish; mesoscutum finely punctured, discal punctures close, separated by much less than one puncture width, anterior margin clothed with tawny or fulvochraceous pubescence except for a thin patch of black hair on each side of middle, disk densely clothed with very short, fine, black pubescence which obscures the surface; tegulae reddish; mesepisterna densely clothed on upper half with dense, silvery-white pubescence with some tawny hairs intermixed, lower mesepisterna, shining subglabrous coarsely, irregularly punctured with an irregular, impunctate area at middle; mesosternum clothed with white pubescence; mesoscutellum densely clothed with short, fine, black pubescence except for a narrow line of white along midline and lateral margins, wings very dark blackish; posterior coxae clothed beneath with white; legs black, clothed with black pubescence except for a subbasal ring of white hair on the tibiae, intermediate and posterior

tibiae with a patch of tawny hairs before apex. *Abdomen* black, dull, clothed with very short, fine, black pubescence except for a broad, transverse, white band on each side of first tergite and a subangular patch along apex and lateral margins on each side of tergites two to five; sixth tergite finely punctured at base; sternites dull, tessellate, clothed with short, fine, black pubescence. Length: 10 mm.

Male.—Pubescence of face and pleura silvery white; wings fuscous throughout, anterior and apical margins darker; intermediate and posterior femora densely fringed beneath with short, black hairs; seventh abdominal tergite deeply notched at apex. Length: 11 mm.

Holotype: Female (No. 4775 Calif. Acad. Sci., Ent.) from 10 miles northwest of San Bartola, LOWER CALIFORNIA, July 13, 1938, and *allotype:* Male (No. 4776 C. A. S. Ent.), from Triunfo, Lower California, July 13, 1938, both collected by E. S. Ross and A. E. Michelbacher.

This species may be readily recognized by the very dark wings and the punctation of the vertex, mesoscutum, and lower half of mesepisterna.

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BOOK NOTICES

VERNON KELLOGG, 1867–1937. Pp. xi and 160, portrait, 1939. Published by the BELGIAN AMERICAN EDUCATIONAL FOUNDATION, INC., 420 Lexington Ave., New York. Apparently a gift volume.

This is a volume of appreciations by associates of Vernon Lyman Kellogg, a founder and charter member of this society, of which he was President in 1915. Professor Kellogg's later accomplishments in Belgium and in central Europe as a great humanitarian, and later in America as a leader in the highest scientific circles, tend to obscure his accomplishments in zoology and in entomology during early and middle life. This very appreciative volume naturally emphasizes his later activities when working on the stage of world affairs.

The writer had the pleasure of being in Kellogg's last classes, those in "Evolution" and in "Heredity" given in 1914–1915, the winter before his career as a world figure opened with service in the Belgian relief work. I shall try to show why we admired this humorous man of science, this poetic writer of broadest sympathies and worker of endless energies.

Kellogg enjoyed entomology. It thrilled him. This thrill was contagious. It is what elevated him as a great teacher. His almost worshipful approach to his favorite science is shown by the following from "American Insects":

"We do not shut up our singing insects in cages as the Japanese do, and bring them into the house to cheer or amuse us, but we do enjoy them, and were our summer and early fall days and nights to become suddenly silent of chirping and shrilling, we should realize keenly how companionable crickets and grasshoppers and katydids had been for us. A wholesome blitheness and vigor and ecstasy of living rings out in the swift and steadfast song of most of our field and wood insect singers, while the cheeriness of the cricket on the hearth is familiar in poetry and proverb."

From entomology Kellogg plunged directly into Belgian relief, as Hoover's right hand man. Shortly, because of his fluent use of the language, his tact and knowledge of the details of relief, he was permitted to cross into Germany to handle relief for French areas behind the German lines. He was stationed for months with the highest German military officers at Great Headquarters. His book "Headquarters Nights" is one of the most illuminating analyses of the German way of thinking which we have. Speaking of his personal quarters, managed by his guard, Graf W.:

"Our house was rather a favored centre, for 'my officer,' Graf W., is a generous entertainer. . . . The discussions, begun at dinner, lasted long into the night . . . and always we talked and tried to understand one another; to get the other man's point of view, his Weltanschauung.

"Well, I say it dispassionately but with conviction: if I understand theirs, it is a point of view that will never allow any land or people controlled by it to exist peacefully by the side of a people governed by our point of view. For their point of view does not permit of a live-and-let-live kind of carrying on. . . . "

As the Annals serves all of Europe we cannot quote further. We recommend "Headquarters Nights" as a crystal clear analysis of German Kultur.

After the Great War Kellogg returned to America and became permanent secretary of the National Research Council, which place he held until he retired in 1931. He was a member of the National Academy of Sciences, a trustee of the Rockefeller Foundation and on its executive committee. Because of these connections and those with other bodies, he was a leader in the higher national and international scientific activities.

From experiences at Stanford during the last two years of Kellogg's professorship in entomology several of his characteristics stand out in the writer's memory.

Kellogg at that time was in his late forties but had yet the fields of his greatest accomplishments before him. One's first impression of him was his boundless energy. It was a commonplace for him to arrive promptly at eight in the morning, dictate steadily until noon and after lunch dictate until late in the afternoon. As we came to know him better we were impressed with the thoroughness of his preparation for lectures, in expressing himself exactly in routine correspondence,

in fact, whatever he did, he did as thoroughly as he could. By this attitude of personal study and self drill he was constantly training himself for a more finished production. This drill and self-training fitted him for the greater things he handled so easily when his opportunity finally came.

Perhaps the memory which his students treasure most was that of his appreciation of their sincere but crude productions. In conference he pointed out the excellencies of the student's work and only thereafter did he make suggestions as to how the poorer parts could be tuned to the well done portions. After appreciative comment the student was fortified for searching criticism so that such did not appear personal. During the two years' contact I do not recall any remark of Kellogg's which might be construed as a braggart statement. In fact, he made the statement to the writer that early in his research he found that he lacked some trick of originality, that little flame of genius, that made the truly great research man, because of which he turned his efforts to the integration and summarization of the work of others. He was a truly great man in his ability to recognize the good in others, to see his own shortcomings and, again, in his tenacious effort to train what abilities he possessed.

This little de lux volume of appreciations is the visible evidence of his great ability to contact persons and personages across the world and in all walks of life. —C. H. K.

OUTLINES OF BIOCHEMISTRY. THE ORGANIC CHEMISTRY AND THE PHYSICO-CHEMICAL REACTIONS OF BIOLOGICALLY IMPORTANT COMPOUNDS AND SYSTEMS, by ROSS AIKEN GORTNER. Second Edition. Pages i-xx and 1–1017, 165 text figures, 86 tables, 6x9 cloth. 1938. JOHN WILEY & SONS, INC., 440 4th Ave., New York City. Price $6.00.

Many entomologists firmly believe that knowledge and ideas valuable to them lie buried in the formidable mountains of biochemistry, colloid chemistry, physical chemistry, or organic chemistry. But being busy with the various duties of the economic entomologist, the treasure hunt is postponed from year to year while chemical literature becomes more voluminous and more difficult for the novice to explore. However, complete frustration in chemistry is not necessarily the fate of entomologists. Given will power and a good guide, an entomologist can make expeditions into the land of chemistry and bring out in a reasonable time ideas that should serve him well. As one of the best guides to the areas of chemistry that particularly concern the entomologist and other biologists, we recommend Gortner. Go with him through his Outlines of Biochemistry and, if you had an ordinary background of chemical training, you are certain to come out with modern knowledge and ideas, and a notebook full of research suggestions.

Gortner's book lies between the elementary text and the monograph. It is sufficiently elementary to be understood by a chemically trained entomologist, and, at the same time, sufficiently advanced to be stimulating to the reader who is accustomed to thinking in terms of research. Reference to the results of modern research is made continually with footnote citations of the literature. Often methods are described and conclusions evaluated by Gortner on the basis of his own broad experience. One feels that he is being guided by a man who knows his way around.

The main headings of the second edition are as follows: I. The colloidal state of matter; II. Proteins; III. Carbohydrates; IV. Lignin and the tannins; V. Plant and animal pigments; VI. The lipids and essential oils; VII. The biocatalysts. The author index and subject index are separate. The chapter on oxidation-reduction is by Dr. H. B. Bull, that on the pectic substances is by Dr. J. J. Willaman, and that on the vitamins by Dr. L. S. Palmer. The other 35 chapters are by Gortner, who has done an amazing job of assembling, digesting and organizing information over a wide area of knowledge. He rightly makes the most of work done at Minnesota, because of his personal connection with it. The only work on insects mentioned in the book is that by William Robinson, formerly of Minnesota, on bound water in relation to cold-hardiness. Likewise the only mention of insecticides is in connection with the work of William Moore, formerly of Minnesota, on spreading and adherence of arsenical sprays.

Again we advise entomologists to explore chemistry with Gortner.—F. L. C.

LA BIOLOGIE DES ORTHOPTÈRES by LUCIEN CHOPARD. Pages 1–541, frontispiece, 404 text figures and 4 plates. 10x6.5 inches. Published as Ser. A, Vol. XX of the Encyclopédie Entomologique, by PAUL LECHEVALIER, EDITEUR, Paris VI, 12 Rue de Tournon, France. Price (paper binding) 250 fr. (=$6.65).

We have given notices of other volumes from this valuable series on the biology of various insect groups. We call to mind Balachowsky, "Biology of the Coccids of the western Mediterranean basin" Berland, "The Arachnids of France" and Senevet, "The Anopheles of France and her colonies, Part I." All the volumes are by experts of world recognition in their groups and are elegently illustrated and printed. The "Encyclopedie Entomologique" is a series that will be found to interest graduate students in those departments that cater to such. To the student we will remark that technical French is easy reading because technical terms in modern English are largely of Norman French derivation. We love, fight, and swear in Anglo-Saxon but study and write in Norman French.

The subject matter is divided into thirteen chapters as follows: Chapter I. Geographic Distribution; II. Habitats; III. Orthoptera which construct refuges; IV and V. Reproduction; VI. Development (postembryonic); VII. Production of Sound; VIII. Autotomie and Regeneration; IX. Reflexes and Means of Defense; X. Reactions of Orthoptera to External Factors; XI. Protective Coloration and Mimicry; XII. Variation and Heredity; XIII. The Rudiments of a Social Life in the Orthoptera. Systematic Index. List of Hosts of Parasitic and Commensual Orthoptera. Index to Authors Cited.

The volume is packed with interesting information on habits and structure in this group which the average student thinks of as being primitive and simple in habit. Few northern entomologists realize that in the tropics are Orthoptera with paddle-shaped hind legs that can swim and are at home under the surface of water. Several pages are given to leaf-rollers (Gryllacrids) that tie leaves together with silk for refuges. The curious myrmecophiles and termitophyles are reviewed. Few American entomologists have seen our own Myrmecophila which in the cool early spring when half dormant, can be caught under stones in the nests of local ants.

The two parasitic Orthoptera which stand out are Dermapteroid, Arixenia on bats and the African Hemimerus on rats of the genus Cricetomys. One of the most curious features of Orthopteran conduct is the production of sound. It is produced in so many and such diverse ways one might be led to suppose it to be a necessity of life itself in this insect group. The chapter on protective coloration and mimicry is interesting and gives various illustrations that are hard to explain unless the forms and colors are protective. The final chapter on subsocial forms deals with the family life of such insects as the cockroach, Cryptocercus, of the middle Appalachians and the earwigs where the mother guards her eggs.

Professor Doctor Lucien Chopard of the Légion d'Honneur and Officier de l'Instruction publique is one of the high officials of the Muséum national d'Histoire naturelle and has been a world figure in the study of the Orthoptera since early in the present century. France is fortunate in that men of such high standing are willing to take time out to write biological reviews or summaries of this high type. It is of further interest that enough copies can be sold to finance such ventures.—C. H. K.

RESEARCH AND STATISTICAL METHODOLOGY, BOOKS AND REVIEWS, 1933–1938. OSCAR KRISEN BUROS, Editor, pages vi and 100, 9½ x 6¼ inches. 1938. Published by RUTGERS UNIVERSITY PRESS, New Brunswick, N. J. Price, cloth, $1.25.

Research workers in the fields of economics, psychology, education, and sociology have expressed sincere gratitude to Prof. Buros and Rutgers University for the comprehensive reviews of statistical and methodological books incorporated for the past few years in the Yearbooks of the School of Education. In the present small volume, which is reprinted from the 1938 Yearbook, the editor has extended the usefulness of this service by including reviews of statistical publications from many other fields, including agriculture and biology. The entire book consists of carefully selected reviews, often several for each book, contributed by some of the world's leading statisticians and collected from many science journals.

The listing is alphabetical by authors and is followed by an index of titles and an index of authors and reviewers.

In this country, entomologists are perhaps as widely conversant with statistical methods as any other group of biologists and have, moreover, taken a progressive step by adopting the Fisherian variety of statistics. In acquainting themselves with these methods, entomologists experience little difficulty in choosing between various texts for the unfortunate reason that there are only a few statistical books available, good or otherwise, which are devoted to biological problems. Many special statistical techniques appropriate to particular biological situations are as yet only available in the form of research papers and consequently are not reviewed. In fact, most of the books reviewed here are of no special interest to the biologist, and it would therefore appear that the manual cannot hope to be as useful to the average biological research worker as it has been to workers in other fields. This is seen to be no fault of its editor, however, and with growing interest and increased publication in biometry the manual should eventually become an indispensable guide for experimenters in entomological work. As it is, the book would seem to be interesting reading only for those entomologists who are already well versed in statistics and wish to compare the comments of many experts on the few available books. Nevertheless, this very attractive manual must certainly be recommended for every large research library. Moreover, the inclusion of biological statistics will certainly increase the usefulness of the book for workers in other fields since the methods of R. A. Fisher which have become so popular in small scale biological experimentation may be expected to find increased usage elsewhere.—C. W. C.

A LIST OF THE INSECT FAUNA OF NANTUCKETT, MASSACHUSETTS by CHARLES WILLISON JOHNSON, 1930. Publications of The Nantucket Maria Mitchell Association, 3(2): 1–174 with index to orders, families and genera. THE NANTUCKET MARIA MITCHELL ASSOCIATION, No. 1 Vestal Street, Nantucket, Mass.

The ANNALS appears to have overlooked this list of insects from an island which has had a reputation as the last place of distribution of various species of New England animals. The book was one of the last faunal lists published by C. W. Johnson of the Boston Society of Natural History. A list of the "Spiders of Nantucket" written by J. H. Emerton occupies pages 161–174.

In an interesting introduction Johnson discusses the work of previous collectors and points out the damages to the local fauna and flora by man particularly by his swamp and muck fires during very dry seasons.

The facts which thrilled the reviewer came upon looking up the history and operations of The Nantucket Maria Mitchell Association. The Association is one of women. It is named for the famous astronomer Maria Mitchell who was born on Nantucket in 1818 and who spent much of her life on that island. In later years she was head of the Department of Astronomy at Vassar College where she showed managerial ability in raising an endowment for astronomy at Vassar of fifty thousand dollars. She was the first woman to be made an honorary member of the American Academy of Arts and Sciences, and in later life received many high honors from abroad.

The intellectual activities of Nantucket Island (four by fifteen miles in extent) have been organized into the memorial association founded in 1902. It existed for years on a mere shoestring of income but by 1933 its budget showed annual expenditures of about thirteen thousand dollars. The Association publishes articles on the natural history of the island, and in outside journals, articles on astronomical subjects. It supports one or more fellows at the Harvard Observatory. Besides these activities it maintains a small local observatory and a scientific library open to islanders and visitors.

We cite the Nantucket Maria Mitchell Association as it is one of the few in the United States of so small a size and of such high aims. Any comparable institutions are usually adjacent to a large city or a university from which they derive vigor. It is small institutions of this type that form the backbone of amateur entomology in the British Isles and on the Continent of Europe. The spirit of the Nantucket Maria Mitchell Association has given us a real thrill.

—C. H. K.

ESSAYS IN PHILOSOPHICAL BIOLOGY by WILLIAM MORTON WHEELER. Pages xv and 261. Portrait, 3 text figs. and 2 pls. 5.5x8 inches. 1939. Published by HARVARD UNIVERSITY PRESS, Cambridge, Mass. Price $3.00.

The evening spent browsing through this volume will stand out in our memory as an eveinng of continuous pleasure. Our Puritan conscience? We were not dodging work on the ANNALS. We were not reading beyond the limits of the field of our livelihood, that of biology. *Sotto voce:* We were not relaxing supposedly jangled nerves while observing the pursuit of the heroine by the excitable hero as he leaped from frame to frame of a movie film. For once our conscience was tuned to a thoroughly pleasurable occupation.

With an occasional exchange of letters, we have never had more than a speaking acquaintance with Wheeler. However, there have been several mutual friends so that he has always been one of those friends "once removed." From these links in friendship has been built up our concept of his charming personality. The reading of this volume has been an evening with Wheeler.

The essays which have been published previously in various journals have been selected as representative of the types of thinking which Wheeler enjoyed and as representative products of his remarkably facile expression. Some are serious and have added to sound biological theory. Others verge on satyre, while two are humorous reviews of the insanities of human society. The best of his essays of the latter type has been included. It is "Termitodoxa, or Biology and Society," which caustic criticism of human society is handled as a long letter to Wheeler himself from the King of the Termites (the Queen was too busy laying eggs to respond).

The article on "Carl Akeley's Early Work and Environment" is another essay worth reading as it gives glimpses of Wheeler's induction as a mentally greedy youth into the mysteries of biological research. Wheeler enjoyed all fields except the exact sciences. His biographers state that from the beginning he had little pleasure in abstractions and the symbolic. His early training was in museum work at "Wards Natural Science Establishment." It was largely that of cataloguing objects. In all later research he preferred dealing directly with the objects themselves.

Only two of the essays are on ants, The Ant Colony as An Organism and Some Attractions of the Field Study of Ants. Other subjects are Jean-Henri Fabre; On Instincts; Organization of Research; Dry-Rot of Academic Biology; Emergent Evolution; Carl Akeley's Early Work; Present Tendencies in Biological Theory; Hopes in the Biological Sciences; Animal Societies.

When we first saw the announcement of this volume we thought of it as a gesture from friends. We are exceedingly glad it fell to our lot to write a notice of it, otherwise we would have missed one of the enjoyable volumes of the year. All entomologists should know Wheeler. This volume gives the reader an insight into the drives, the intense longings, of a unique man—one who appreciated all phases of intellectual life.—C. H. K.

THE WATCHER AT THE NEST by MARGARET MORSE NICE, 159 pages, 21 figures. 8.5x6 inches, 1939. Published by the MACMILLAN COMPANY, 60 Fifth Avenue, New York. Price $2.00.

This popular summary of Mrs. Nice's remarkable studies of the home life of some of our common birds has had an artist designer or clever compositor somewhere in its formative period. It is refreshingly different in its design from that of the average book-stand volume. The chapter headings, chapter numbers and the simple sketches of birds and bird activities are vigorous in their simplicity. We protest the lack of an introduction. In fact, when we could not find one at the front of the volume we turned to the end, then we explored the area around Chapters X and XI on the thought that we might have before us an example of futuristic art with elements set beyond their appointed time.

However, it has no introduction. The reader opens the book in the middle of a rose hedge with the two song sparrows, Uno and 4M. "Uno claimed all the land around the house, the steep bluff directly west of it, and the three Norway maples in the garden proper, while 4M was owner of the ground beyond, starting with the hedge and including a box elder and a great silver maple on a meadow of

bluegrass. That this ownership was no mere figure of speech will be evident; the land was defended and won by age-old ceremonies and fierce battle, as definitely as in our courts of law, a piece of ground being released and quitclaimed by one bird and lawfully seized by the other."

The first half of Mrs. Nice's volume covers in detail the daily life of the pairs of song sparrows about her home on the Olentangy River (at Columbus, Ohio). Some of the chapter headings are: I. The way of a song sparrow; II. Una builds three nests; III. The nest in the rose hedge; VII. Two divorces and a happy ending; VIII. 4M and Xantippe; X. The grandchildren of Uno and 4M. Chapter XI covers the relations between the local cow birds and the various nesting pairs of song sparrows. The charm and interest lie in the decided differences in the personalities of the various song sparrows. Uno was a mild bird with four songs. 4M was a disputatious male with nine or ten songs. Some feared snakes. Others ignored them. Each pair had its recognized territory which the pair seldom left during the nesting season. This area was won and defended by singing and other stunts and finally by fighting.

The other eight chapters deal with eight other species observed at the summer home in Massachusetts or on the campus of the University of Oklahoma. Altogether this book is charming. It will interest anyone interested in birds. Mrs. Nice's observations on bird life rate as some of the finest ornithological field work that has ever been done in this country or abroad.—C. H. K.

THE BOY'S BOOK OF INSECTS by EDWIN WAY TEALE. Pages 237, 24 text figs. and 31 full page photographs (halftones). 1939. Published by E. P. DUTTON AND CO., 300 Fourth Avenue, New York. Price $2.00.

This well organized volume is written for the active out-of-doors boy of high school age or a year or so earlier. It is for the boy who has already acquired the ability to read and who has ability to construct simple cages, nets and other entomological equipment. The point of view and field covered is shown by the list of equipment suggested early in the volume. This list includes a net, killing bottle (carbona), tweezers, jackknife, note book, magnifying glass, jars, tins and pill boxes and "The Fieldbook of Insects" by Lutz.

In this volume taxonomy is omitted in its entirety. Except incidentally in the text ordinal names are omitted. The nearest approach to this phase of entomology is the bibliography of six pages which lists works by general headings but which is largely composed of titles of works on habits and titles of a popular nature.

In their uniformly high illustrative quality the thirty-one photographs are as fine a series as we have seen in any work on insects. The author-artist knows how to handle lighting for remarkably effective photography. He is more than an expert with a camera. He is an artist.

There are twenty-one short chapters and even the titles are interesting. Besides a series of chapters on insect groups, "The Beetles," "The Butterflies," "The Ants," etc., there are chapters such as "III, Making Your Equipment," "V. Beetle Hunting," "VIII. Organizing Your Collection," "X. How to Build an Ant House," "XIV. Collecting With a Camera," "XVII. Insect Aquariums," "XXIII, Hunting With a Flashlight," or "XXV. Keeping an Insect Zoo."

This book has been written for that age when the expanding intellect of the boy "wants to know the truth." The temptation to hand him fairy stories of nature is past. He is stepping over the threshold into the edifice of science. Thus is indicated a volume, scientific in all statements but in a scientific language of a simplified form. We feel from what we have seen of the volume, that it is the best book for high school age we have reviewed. However, we have not yet seen the volume tried out in the hands of one of that very uncertain mind found in the boy of high school age. The author has worked this book out with his own boy, consequently in actual use it will probably be found to be most effective and interesting to the boy when used as a parent-son guide to insects. The volume is too well done not to have high value in some area of the high school age of boy development. We fear that even girls would like to use this "Boy's Book of Insects" surreptitiously. The author has put ability, experience and work into it.—C.H.K.

PRINCIPLES OF DEVELOPMENT, A TEXT IN EXPERIMENTAL EMBRYOLOGY by PAUL WEISS. Pages xix and 601. 124 text figs., 8.75x5.75 inches. 1939. Published by HENRY HOLT AND COMPANY, 257 Fourth Avenue, New York. Price $5.00.

Biologists have been looking forward for some time to the appearance of this volume by Paul Weiss. Now that the work is actually before us, it more than measures up to our anticipations. We had not realized that experimental work in embryology had given us such a consistent body of the general principles of embryological development. Professor Weiss' whole thought is that of an enquirer, his whole attack is that of analysis by experiment, while his summary of principles takes the form of an adequate natural philosophy.

The "Contents" are divided into four parts which, because each, to more or less extent, uses the same or similar experimental examples, appear at times to overlap. However, on closer study this apparent repetition is not one in fact. It is rather a method of tying the various phases of the very complex subject together. The work is a remarkable piece of exposition. Its organization is one of its excellencies. The main items in its structure are as follows:

Part I. Phenomena of Development.

This breaks down into: A Definition of Development; an Inventory of Development; and Problems of Development. Pages 1–116.

Part II. The Methods of Studying Development.

The subheads are: History of Embryological Methods; Descriptive Methods; Experimental Analysis; and Model Experiments. Pages 117–178.

Part III. Principles of Development.

This is the meat of the book and is organized as follows: Initiation of Development; Preformed Organization; Progressing Organization; Gradual Determination and the Field Concept; Reintegration; Regeneration; Malformations. Pages 179–490.

Part IV. Development of the Nervous System.

Description of the Nervous System; Neurogenesis; the Development of Behavior. Pages 491–573.

Part I clears the way for Parts II and III. In it the author defines "development." He differentiates developmental events from recurrent physiological events. He defines reproduction and differentiation. He discusses and defines principles, mechanisms and systems.

Part II discusses experimental methods and their limitations. For the first time specific experiments are cited. In the volume each experiment is serially numbered. The total of experimental examples is 130. ("Example 130," p. 568.) The methods of studying external factors and of studying internal factors are outlined.

Part III. The discussion of the principles of development starts with the activation of the egg cell. Any mechanism of development set up in the egg by the processes of heredity previous to activation, whether by sperm or by other means in parthenogenesis, is left to the field of genetics. He discusses the role of fertilization as dual but in development as a trigger reaction starting the process. A series of experiments are cited showing the amount of preformation to be found in the eggs of certain groups of animals and its effect at various levels of development. Perhaps the high area of the volume is his clear analysis of the concept of dynamic "fields" in development; under what conditions they are operative, over what they have control and how various fields relate to each other. Physiological gradients come in for their place in the scheme of development. Part III closes with the bearing of the study of regeneration and malformations on the subject of normal development.

Part IV, Development of the Nervous System, is a review of what we have found out about the development of one system of the animal body, in this case the most complex system.

While this is a medium priced volume we are recommending it to all college students who plan to spend their lives in a biological science. Five dollars in books cannot buy more. It is by a world authority. It is not merely another textbook. When one realizes that each and every animal originates as a microscopic speck of protoplasm which then develops into what it eventually becomes, it seems miraculous. Paul Weiss has analyzed for us much of this apparent miracle. It is one of the half dozen outstanding biological volumes of the past two or three years.—C. H. K.

MEDICAL ENTOMOLOGY. A SURVEY OF INSECTS AND ALLIED FORMS WHICH AFFECT THE HEALTH OF MAN AND ANIMALS, by WILLIAM A. RILEY and OSKAR A. JOHANNSEN. Second edition. Pages I-XIII and 1–483, 184 text figures, 6x9, cloth, 1938. Published by MCGRAW-HILL BOOK COMPANY, INC., 330 West 42nd St., New York, N. Y. Price $4.50.

The preface to the second edition mentions the topics which required revision since the first edition was published in 1932; e. g., black widow spider, kala-agar and Phlebotomus, equine encephalomyelitis and mosquitoes, screw worms, and jungle yellow fever. For those not familiar with "Riley and Johannsen," it should be pointed out that emphasis is placed on the taxonomy and biology of hominoxious arthropods and that these are considered in the order in which arthropods are usually classified. Medical entomology is such a vast field that no one book can be expected to cover every aspect of it in a thorough, authoritative manner. The subject embraces not only the arthropods responsible for affecting the health of men and animals, but the pathology and treatment of the effects produced, the microbiology of prothogens transmitted by arthropod vectors, and the chemistry of toxins. Distribution of arthropods, ecology, control, and economics also enter the picture. We doubt that any other authors, known for their work in entomology and parasitology, could have done a better job in presenting an understandable picture of the whole subject, but the reader should be warned not to expect too much in subjects entirely outside the experience of the authors.

This reviewer would be more incompetent in taxonomy and morphology than the authors are in control, and therefore begs their pardon for pointing out that they should have had the collaboration of one of their insecticide minded colleagues in revising the various sections on chemical control. The principal fault of these sections is that they do not reflect present methods of control and mention various methods of control indiscriminately, some of which are good and others worthless, impractical or dangerous. It is a serious mistake not to have pointed out that fumigations for the control of household pests should be done by experienced pest control operators and not by laymen. To state, as is done in the appendix, that Strand's directions for HCN fumigation can be carried out safely by any responsible adult, is to take a grave responsibility that the reviewer would never assume. Gas mask protection, methods for resuscitating individuals overcome with HCN, and local ordinances on HCN fumigations are not mentioned. We hope that this invitation to suicide will be removed from the next edition.

Selected references to the literature since 1932 are appended to the bibliography of the first edition. Only a subject index is given.—F. L. C.

THE ORIGIN OF LIFE by A. I. OPARIN; translated by Sergius Morgulis. Pages viii and 270. 5.75x8.5 inches. Published by THE MACMILLAN COMPANY, 60 Fifth Avenue, New York. Price $2.75.

The author, Doctor A. I. Oparin, is Associate Director of the Biochemical Institute of the U. S. S. R. Academy of Science in Moscow. Prof. Morgulis is Professor of Chemistry at the College of Medicine of the University of Nebraska.

Chapter I, Spontaneous Generation, reviews the century of argument over spontaneous generation until it was effectively settled by Pasteur for all life above the ultramicroscopic. Chapter II, The Continuity of Life, discusses the possibility of life having reached the earth across interstellar space. Our present knowledge of radiant energy in outer space suggests that it would be impossible for living matter to drift long without being reduced to the simplest elements by radiant bombardment. Chapter III, Origin of Life at Some Distant Period, reviews the many suggestions, from Bastian, 1872, Haeckel, 1878, Weismann, 1902, and others, on the possibility that life originated at some early period of the earth *when some special conditions existed* which may not exist now. At the close of this chapter the author states his own thesis. "We do not need to invent special, unknown forces for this. The conditions for the origin of living things are the same as the conditions under which organic substance has been gradually evolving. The first prerequisite condition was the primary mass formation of such organic substances. It is absolutely unthinkable that such complex structures like organisms could have been generated spontaneously directly from carbon dioxide, water, oxygen, nitrogen and mineral salts. The generation of living things must have been inev-

itably preceded by a primary development on the earth's surface of those organic substances of which organisms are constructed."

Chapter IV, Primary Forms of Carbon and Nitrogen Compounds, gives us the author's point of view which has been arrived at from his study of the structure of organic compounds and particularly his knowledge of their derivation from inorganic substances. This chapter is an elaborate discussion from astronomical, physical and chemical data as to the earliest forms of carbon compounds following the cooling of the planet. "Carbon made its first appearance on the earth's surface not in the oxidized form of carbon dioxide but, on the contrary, in the reduced state, in the form of hydrocarbons."

Chapter V, Origin of Organic Substances, Primary Proteins, brings the reader through some simple organic chemistry to the possible formation of amino acids and of acidic carboxyl groups under natural (inorganic?) conditions. The author closes the chapter: "Protein is by no means living matter, but hidden in its chemical structure is the capacity for further organic evolution which, under certain conditions, may lead to the origin of living things." As stated by Endel: "Life is a form of the existence of protein bodies."

Chapter VI, The Origin of Primary Colloidal Systems, deals with the arrangement and relationships *inter se* of the simpler organic radicals in chains, rings and of larger aggregates in colloidal systems.

Chapter VII. Origin of Primary Organisms, shows how sluggish the simpler organic substances are and discusses their intense activities as induced by various activators such as enzymes and by chains and combinations of such activators. Matter is not really living until these activators evolve. Chapter VIII, Further Evolution of Primary Organisms, discusses the food problem. The author believes that primary living organisms ate the earlier, primary "organic" matter, that photosynthetic and other autotrophic organisms are a later development (perhaps after the earlier food supply ran short). Chapter IX, Conclusion, is a summary.

To the reviewer the argument in this volume appears to be solidly grounded on accepted scientific fact. If so, it fills a gap in our philosophy of life.—C. H. K.

HANDBOOK OF HISTOLOGICAL AND CYTOLOGICAL TECHNIQUE by R. R. Bensley and S. H. Bensley. Loose leaf, 9.5x11 inches. 167 pages. Linen cover. University of Chicago Press, Chicago, Ill. Price $2.00.

The University of Chicago has been a center of the development of microtechnique on both plant and animal tissues for many years. Apparently when one or two individuals become intensely interested in such work the interest becomes infectious and is passed into other departments and is applied to other related subjects. Thus does a personal interest become communal.

The present volume is a laboratory guide based on the techniques found most useful by the staff of the Department of Anatomy of the University of Chicago. Thus it is primarily a technique for vertebrate tissues. It has one other specialization (or limitation). The interests of the Department of Anatomy have been on the internal anatomy of the cell. They have "been in regard to the cell, not so much as an integer of tissue structure and function, but in the study of its components and of their functional variation. . . . We have attempted to restrict the techniques to those which have been most valuable, in our experience, to beginners in this field."

The volume is organized as follows:

Part I. Introduction; II. Methods for Studying Dead Cells; III. Methods for Studying Surviving Cells; IV. Methods for Studying Living Cells; V. The Altmann-Gersh Freezing-Drying Method.

Part II. Techniques for the Study of Fixed Tissues. VI. Introduction; VII. General Rules; VIII. Fixation; IX. Imbedding; X. Sectioning and Mounting; XI. Staining; XII. General Tissue Stains; XIII Blood Stains; XIV. Staining Cell Constituents and Inclusions; XV. Glands; XVI. Selective Stains; XVII. Neurohistological Methods; XVIII. Visible Microchemical Reactions; XIX. The Freezing Microtome and Frozen Sections; XX. Decalcification; XXI. Miscellaneous Techniques. References. Index.

The excellence of the volume is the careful selection of the techniques cited and their regular use in the Department of Anatomy until their shortcomings have

been ironed out. The defect of the volume is the lack of credit to other workers, the lack of documentation which would have permitted the student to browse further into the literature. The bibliography covers less than one page and gives only general treatises on the subject, twenty altogether. The portion of the volume which appeals to us is that of the first thirty pages which deals with living or freshly killed tissues. This is a subject which has been avoided oftener than not in various, even rather recent, texts.

The binding is that of a loose-leaf note book which opens flat on the work table. The type used is very large, eleven point, and two point leaded.—C. H. K.

A CATALOGUE OF THE ORIGINAL DESCRIPTIONS OF THE RHOPALOCERA FOUND NORTH OF THE MEXICAN BORDER, edited by F. Martin Brown and R. W. L. Potts. Part two. The Satyridae, by Cyril F. dos Passos. 13 pages. Bulletin of the Cheyenne Mountain Museum, Vol. I, Part II, 1939. Price fifty cents.

The first part of this catalogue was noticed in the ANNALS for December, 1938. In the second part a few changes have been made: Synonyms are set in lower case italics, genotypes are bracketed below the generic references and set in small bold-face, and major subspecific categories—subspecies of the editors—are designated by serial letters. The first of these changes greatly improves the appearance of the pages and the others will be found useful. The present format is decidedly effective for a work of this kind.

Part two must impress the reader by its inclusion of seven species and thirty-one subspecific names established since the publication of the Barnes and McDunnough *Check List*. One can only conclude that Mr. dos Passos and the others who have worked in this family have been very diligent both in collecting and in studying material. Diligence alone can make such corrections as that in *Minois ariane* Bdv. on page 8, which seems now to be definitely established.

As a popular group, this entire order has been too much subject to compromise based on inadequate material and imperfect knowledge of previous work. An era seems to have arrived for the careful revision of limited groups by specialists, and this catalogue is a fine example of the results that may be expected.

Unfortunately such revisional procedure seems always to bring a multiplication of subspecific names. Sixty-nine, exclusive of aberrations, in a family of sixty species, seem to the reviewer an unnecessary complication of the nomenclature that could be avoided by simple notice of tendencies in variation in works where such notice is needed. This is, of course, a matter of opinion and in no way a condemnation of the writer who carefully places the names that have been established.

The compact statement of original references and type localities in this catalogue makes it a very useful work. While check lists have not been lacking, the publication of a good catalogue of Lepidoptera has seemed more and more remote. The sponsors are to be congratulated on their solution of the practical difficulties involved.—A. W. L.

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The Annals of the Entomological Society of America, published by the Society quarterly, includes the Proceedings of the Annual Meetings and such papers as may be selected by the Editorial Board.

Papers may be submitted to any member of the Editorial Board and should be as nearly as possible in the form desired as final, typewritten, and illustrations finished complete ready for reproduction. Plates must not exceed 4¼x6¾ inches unless intended to fold. Cuts for illustrations are charged at cost to the author. In general, papers to be accepted must be original, complete and previously unpublished. Authors will be allowed fifty reprints gratis and additional copies at cost to the Society.

The Managing Editor is provided with the most recent address of all paid-up members on record in the Secretary's office for mailing the numbers of the Annals and members failing to receive their numbers should present their complaint to the Managing Editor within four months from the date of the mailing of the issue. After that time the numbers will be furnished only at the regular published rate.

Requests for information as to membership and annual dues of members should be sent to the Secretary-Treasurer, PROF. C. E. MICKEL, Dept. of Entomology, The Farm, University of Minnesota, Saint Paul, Minn.

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